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CONTENTS

	PAGE
Establishment of New Industries	777
Agricultural Development in Great Britain	779
God or Mammon? By J. C. H.	779
The Flora of North-east Ireland. By Dr. W. B. Turrill	780
A Guide to Plant Genetics. By D. G. Catcheside	781
The Claims of Logical Positivism. By Dr. Thomas Greenwood	782
Plastics and Some Recent Applications. By H. V. Potter	785
Hydrocarbons in Industry. By Prof. Eric K. Rideal, M.B.E., F.R.S.	788
Growth of Induced Plant Tumours. By Dr. László J. Havas	789
Obituary Notices:	
Prof. W. Cramp	791
Prof. F. J. Cheshire, C.B.E.	792
News and Views	813
Research Items	819
Pleistocene Stratigraphy of the Breckland. By T. T. Paterson	822
British Empire Telegraph Communications	823
The Gorge Dam, Hong Kong	824
River Physics in India	825
Science News a Century Ago	826
Societies and Academies	826

SUPPLEMENT: Letters to the Editor

NUCLEAR PHYSICS

Control of the Chain Reaction involved in Fission of the Uranium Nucleus.—Dr. F. Adler and Dr. H. von Halban, jun. 793

Decay Curves of Uranium and Thorium Fission Products.—Dr. T. Bjerge, K. J. Brostrøm and Dr. J. Koch 794

Tracks on Photographic Plates of the Recoil Nuclei of Disintegration of Uranium.—Prof. L. Myssowsky and A. Jdanoff 794

Short-Range α-Particles from Oxygen, Nitrogen and Fluorine Bombarded with Protons.—W. E. Burcham and C. L. Smith 795

The Meson and its Transformation into Heavy Particles.—Dr. R. C. Majumdar and Dr. D. S. Kothari 796

PHYSICS AND CHEMISTRY

Preliminary Report on the Masses of ^{13}C and ^{14}N.—T. Asada, T. Okuda, K. Ogata and S. Yoshimoto 797

Discrepancies in the Isotopic Weight of ^{13}C.—Dr. F. W. Aston, F.R.S. 797

Rigidity of Liquids.—Sir C. V. Raman, F.R.S., and C. S. Venkateswaran 798

Anomalous Properties of some Anhydrous Salts of the Iron Group at Low Temperatures.—S. Shalyt 799

Experiments on Pumping Liquid Helium to Low Temperatures.—A. H. Cooke and R. A. Hull 799

Polymorphism of the Micas and Diffuse X-Ray Scattering of Layer Silicate Lattices.—Dr. Sterling B. Hendricks 800

Interrelation of Dissociation Energy, Internuclear Distance and Bond Order for Carbon-Carbon Linkages.—Dr. C. H. Douglas Clark 800

Demonstration of Optical Interference Figures.—Dr. H. E. Buckley 801

Measurement of the Amount of Steam Escaping from Areas of Volcanic or Solfataric Activity.—Stuart H. Wilson 802

Benzil—a Skew Molecule?—C. C. Caldwell and Dr. R. J. W. Le Fevre 803

The Vector Map of the Cyclol C_9 Molecule.—Prof. E. H. Neville 803

BIOLOGY

Effects of Veiling Glare in Binocular Vision.—B. Babington Smith and Dr. R. W. Pickford 804

Changes of Average Maternal Age.—R. S. Barclay and W. O. Kermack 804

Variations in Follicle Population Density in the Merino Skin.—H. B. Carter 805

'Frequency Discrimination' in Insects: a New Theory.—R. J. Pumphrey and A. F. Rawdon-Smith 806

Sponge Mortality in the Bahamas.—Dr. Paul S. Galtsoff, Dr. Hubert H. Brown, Dr. C. Leslie Smith and Dr. F. G. Walton Smith 807

Growth of *Borrelia duttoni* in the Developing Chicken Embryo.—R. Knight Oag 808

Genetic and Cytological Interference.—Prof. C. L. Huskins and H. B. Newcombe 808

Influence of Colchicine on the Sexually Induced Colour Change of *Rhodeus amarus*.—Dr. László Havas 809

Alimentary Exudative Diathesis, a Consequence of E-avitaminosis.—Henrik Dam and Johannes Glavind 810

Role of Manganese in the Biological Synthesis of Ascorbic Acid.—M. N. Rudra 811

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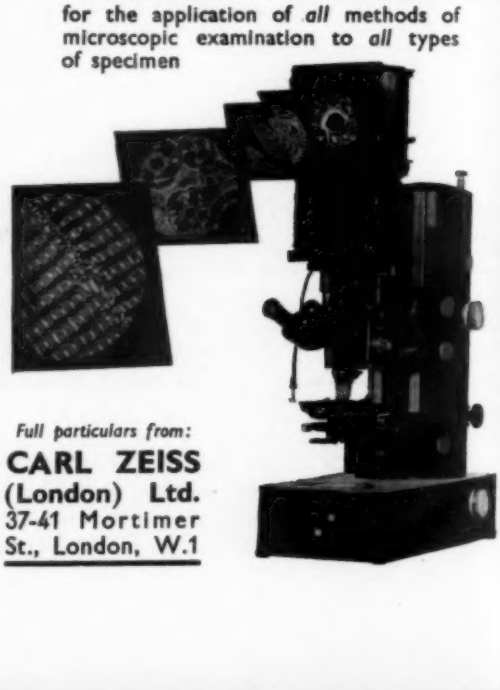

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Establishment of New Industries

THE major proposals of the report on the location of industry recently issued by Political and Economical Planning (P E P) have already been outlined in these columns (NATURE, May 6, p. 770). From discussions of the report and its contents, however, it is apparent that a number of points raised by it are being overlooked. Among such matters of special interest to scientific workers is the suggestion that the proposed Industrial Development Commission should be empowered to advance money for the promotion of new industrial enterprise. This problem is discussed in some detail.

To a large extent the provision already made by the Special Areas (Amendment) Act of 1937, the Nuffield Trust and the Special Areas Reconstruction Association, Ltd., meets the need of new factory enterprise which is concerned with the manufacture of an established product or of a product not already made in Great Britain. The manufacture of an entirely new product or the establishment of a novel process is another matter, and the comments of the report on this subject may well raise doubts as to whether the Committee on Industrial Development, in its report issued in 1932, was not much too confident that there was no gap in our existing structure for the finance of development and research.

The present report does not consider that the difficulties in the way of developing entirely new processes or inventions are altogether the fault of financial institutions. Moreover, the few companies which have been formed specially to deal with new inventions do not appear to have had any great measure of success ; the necessary link between invention and finance has not yet been forged.

One of the major difficulties is the aggregate cost of 'vetting' new propositions, which frequently exceeds the profits to be anticipated on the small proportion of successful ones. The high cost is due to the difficulty of finding any firm or organization capable of dealing with the wide range of industries into contact with which a concern attempting to finance new processes is usually brought. The difficulty has been recognized, of course, for many years, and in November 1935 the Chancellor of the Exchequer made an important statement putting the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council at the disposal of banks, issuing houses and brokers to furnish them with reports on the scientific merits of the methods or substances for the development of which it might be proposed to make a public issue.

While, however, the three research organizations in question could undoubtedly be of far greater use to industry and finance, it is at least open to doubt whether they possess invariably the necessary combination of commercial and technical outlook. The nature of their responsibilities limits them to making a complete and exhaustive report on a technical subject. What is often required, however, is a quick opinion based on sound judgment and wide knowledge as a basis for a decision whether to proceed with further investigation or to reject the project at an early stage. The commercial prospects as well as the technical soundness of the process must be taken into account, and the appreciation required must consist not merely in the verification of technical claims but also in forecasting the demand for the new product, and the forces which determine it,

the output of competitive products, the location of manufacture, the areas or industries in which they are sold, relative costs and selling prices, patent aspects, and other economic and technical factors.

At least it may be held that the establishment of the information service recommended in the P E P report should assist in dissipating the very serious lack of technical knowledge in financial circles, which may be regarded as responsible for its failure to restrain or check the excessive over-capitalization of new companies. Moreover, if the view is correct that the evolution of better facilities for the finance of new industries would be an important contribution to the problem of the Special Areas, it should be of no less service to areas which are in danger of becoming depressed through their dependence on a limited number of industries. It is therefore considered that stimulation of private enterprise in co-operation with Government enterprise may offer a solution. The proposed Industrial Development Commission accordingly should explore with business men the possibilities of setting up one or more specialized institutions to deal with the financing of new enterprises generally, and should be empowered to subscribe a proportion of the capital of any such institution. If the machinery then erected became effective and wide enough in its scope, the necessity for direct financing by the Commission of individual enterprises would be materially reduced and might eventually disappear.

There is yet another direction in which the report suggests the need for investigation by the proposed Commission. Any truly scientific policy of industrial development must take account also of both the preservation and restoration of amenities. Even with the examples of the depressed areas in front of us, as well as the encroachment on amenities which on a smaller scale is taking place all over the country, it is no simple matter to decide just how best to provide the necessary safeguards without unduly hampering industrial expansion.

The report itself recommends that the Commission should be given discretionary powers to attach conditions to licences, obliging manufacturers to provide for the safeguarding of local amenities or their restoration, if damaged or destroyed. This is one of the most important services that the Commission could render to the community; the widespread destruction which has resulted in the past from unrestricted development by private enterprise is sufficient indication of the need for preventing such destruction in future.

The mere institution of licensing powers should assist, for the Commission would consider this factor along with others in handling applications for licences. The efforts of public authorities to preserve amenities through town planning regulations should be substantially reinforced by this fact alone. Public policy, however, can do little or nothing to deal with the root cause of such nuisances as arise from the decline of the industry or enterprise itself and its eventual abandonment. It is possible, nevertheless, to take steps in advance to prevent the repercussions on local society as a whole from becoming too drastic. The report suggests that one way of dealing with this problem would be by means of a sinking fund.

This again is a matter for investigation by the Commission. Any such fund should be earmarked for the restoration of local industrial and social amenities, where necessary, in the future transfer or liquidation of any factory. The other aspect of this question—the extensive salvage operations which are already necessary to restore certain areas to a condition in which they can again become usable for industrial and social purposes—equally falls within the orbit of the Commission. Restoration of such areas should have an early claim on any Government funds available for general public works purposes, and the Commission would be the most suitable body through which the planning of restoration projects and the distribution of funds to local authorities could be carried out. In this respect, indeed, it would develop the pioneer work of the Commissioners for the Special Areas.

The suggestions of the report regarding these two problems, which are by no means so far separated as might appear at first sight, well illustrate its admirable balance. The care for industrial development is never allowed to overshadow the fact that the efficient utilization of the resources of the nation involves safeguarding the health and social well-being of its citizens and the natural amenities of the country. The exposition given in the report of the need for further scientific investigation in these matters, no less than the vision it gives of the possibilities if industrial development and the erection of new towns are viewed in their true perspective as creative social enterprise, will be widely welcomed. Nor does the report leave scientific workers in any doubt that they may well be called to make a decisive contribution, if these possibilities are to be realized.

Agricultural Development in Great Britain

A Policy for British Agriculture
By the Rt. Hon. Lord Addison of Sittingborough. Pp. 304. (London: Victor Gollancz, Ltd., 1939.) 7*s*. 6*d*. net.

THE agricultural policy of the Labour party, as presented in Lord Addison's book, has as its objective the restoration of British agriculture. As in the case of Lord Astor and Mr. Seebohm Rowntree, Lord Addison believes that agricultural production in Great Britain should be stimulated by the adoption by the Government of a policy of improved nutrition. Recent reports on nutrition are quoted to show that the poorer sections of the population are inadequately fed, and it is calculated that in order to bring the food standard of the community up to a reasonable level it would be necessary to double our production of milk and to increase our production of eggs, fruit, vegetables and meat by 60, 78, 60 and 25 per cent respectively.

Quoting Scandinavian experience, Lord Addison considers that livestock production in Great Britain should be based on arable rather than pasture farming, and recommends that there should be a large extension of arable acreage (back to the total of the 'seventies) including a large additional home production of wheat. In fact, he considers that our wheat acreage should be doubled, although how this is to be achieved at the guaranteed price he recommends—37*s*. 6*d*. a quarter instead of the present figure of 45*s*.—does not emerge.

All these increases in production would, on Lord Addison's hypothesis of an adequate standard of nutrition, leave unaffected our existing imports of food, and would, in fact, call for a considerable addition to our present importation of animal feeding stuffs.

Other recommendations include the nationalization of the land, the fixing of guaranteed prices to farmers, the re-organization of marketing and the payment of higher wages to agricultural workers.

Little is said about the cost of Lord Addison's proposals, but he is critical of the present "mixture of tariffs, quotas and quantitative regulation" which "is now being sought to be atoned for by a system of subsidies". He considers that the only self-respecting and permanent procedure is to have a price system under which the consumer is given an adequate income to pay a reasonable price to the producer.

Much contained in Lord Addison's book is controversial and many of his pronouncements are statements of belief rather than of fact. The methods by which his various proposals are to be put into operation are largely omitted, and the reader may be left with the impression that, although Lord Addison is undoubtedly sincere in his efforts to help British agriculture, he is inclined to over-estimate the benefits and to under-estimate the dangers of the policy he proposes.

God or Mammon?

Christianity and Economics
By Lord Stamp. Pp. xii+194. (London: Macmillan and Co., Ltd., 1939.) 5*s*. net.

THE purpose of Lord Stamp's book is "to review the contacts between the ideals of Christianity and the working of the economic machine". He begins with a chapter on the economic condition of Palestine at the time of Christ, and draws a far from idyllic picture "of over-population, intense industry to keep going, heavy taxation and much discontent". From a careful examination of His recorded teaching, Lord Stamp establishes the conclusion that "Christ did not condemn the institutions and relationships of His day". His teaching is thus for the modern no "ready-made guide, with easy application to the economic life of his own age". The vital link between Christianity and economic life is rather to be found "in the logical extension or consequence of certain germinal, and even explosive, ideas of conduct and interrelationship which Christ taught"; and the essence of those ideas is that they are "personal and voluntary, and not prescribed by any external system or laws".

But Lord Stamp does not confine his treatment of the subject to a study of Gospel precepts and background. His chapter on "Christian Doctrine on Economic Affairs in the Past" gives the history of the actual relationships between Christianity and economics as these have developed and existed in the past. Amongst other things, he shows how the authoritarian economic ethics of the Middle

Ages was subjected to intolerable strain by the sudden rise in prices consequent upon the flow of precious metals into Europe on the discovery of the New World. During the second half of the sixteenth century, the total stock of gold and silver was quintupled.

Passing on to Christian principles and their practical application, Lord Stamp enumerates the following: (1) the brotherhood of man; (2) the principle of stewardship; (3) the doctrine of the good neighbour; and (4) the equality of the value of each individual soul. On the application of these fundamental principles to the conditions of modern life, Lord Stamp gives much valuable guidance.

Lest his work should be regarded too much in the light of a merely personal view, Lord Stamp includes a careful examination of three recent representative pronouncements of organized Christian bodies: first, the Encyclical *Quadragesimo Anno*; second, the findings of the Conference of Protestant Churches on Church, Community and State, held in Oxford in 1937; third, a pamphlet published by the Industrial Christian Fellowship on "The Church and the New Economic Order". He finds in them "a common basis of criticism and condemnation, despite differences of emphasis".

In his final chapter, Lord Stamp raises some significant questions. If we can only avoid poverty by exploiting the machine and by organizing men in industrial subservience to it, "it seems as if material abundance and spiritual are inversely related", as Christ virtually taught. We too confidently assume "that we can have all the material riches that a pagan society teaches us to produce, equally from a truly Christian order". So is it really possible to make the best of both worlds?

Lord Stamp has given us a good book with a clear grasp of facts, principles and values.

J. C. H.

The Flora of North-east Ireland

A Flora of the North-east of Ireland
By Samuel Alexander Stewart and Thomas Hughes Corry. Second edition. Flowering Plants, Vascular Cryptogams and Charophytes, by Dr. Robert Lloyd Praeger; Mosses and Liverworts, by William Rutledge Megaw. Pp. lix + 472. (Belfast: The Quota Press, 1938.) 10*s.* 6*d.*

THE great botanical interest of the flora of Ireland is due not only to the position of the island as a western outpost of the Eurasian continent, but also to the peculiar elements of which the flora is composed and to the differences shown by the flora and vegetation when these are compared with the botanical features of Great Britain. North-east Ireland is, in some respects, less interesting botanically than the western districts but there are compensating features. The matter is stated thus in the introduction to the work at present under notice: "The position of the area is such that it is removed from the regions occupied by the most marked plant-groups to be found in Ireland—the flora of the south-west and west, with its fascinating admixture of Mediterranean, Pyrenean and North American plants; the Central Plain, with its rich assortment of lime-loving and swamp-loving species; and the south-east and east coasts, which connote the presence of species, mostly of southern facies, favouring sandy and gravelly soils. But as will be seen, certain members of all these groups penetrate into the north-east. On the other hand, as a glance at a map might suggest, the region is rich in plants of Scottish type, which here reach their maximum in the country."

The introduction to this new edition makes instructive and pleasant reading. It contains many facts regarding the ecological distribution of the more distinctive species, and the contents are so arranged as to facilitate the researches of botanists desiring to visit the best botanizing areas for special studies. There is also much information regarding the historical development of botanical knowledge of north-east Ireland. The bulk of the book is arranged after the style of "county floras", the sequence of species being that of the Bentham and Hooker system. Valuable historical and distributional notes are included and many references to literature are given. The value of including the critical species of *Rubus* with the proviso that probably the names "cannot all hold permanently" may be doubted. An appendix gives a list, with comments, of casual plants and of those recorded in error.

The inclusion, as Part 2, of the mosses and liverworts is a welcome innovation in Irish county or district floras. A topographical index is also a very useful scheme which might well be widely adopted by authors of similar works. There are an index to plant names and black and white maps of the counties of Down, Antrim, and Londonderry.

W. B. TURRILL.

A Guide to Plant Genetics

Recent Advances in Plant Genetics

By Dr. F. W. Sansome and Dr. J. Philp. Second edition, revised and rewritten by Dr. F. W. Sansome. Pp. xii + 412. (London: J. and A. Churchill, Ltd., 1939.) 18s.

WHEN this book first appeared, it filled a gap by providing a valuable summary of the more modern aspects of plant genetics. The new edition, which has been revised and partly rewritten by Dr. Sansome, preserves the main features of the previous one. There is an entirely new chapter on variegation and chimæras, and the first two chapters have been rearranged with considerable gain in coherence and clarity. Although not designed as a text-book, and in spite of the limitations imposed by the authors in their preface, it forms a very satisfactory introduction for the student of genetics. Through a logical sequence it succeeds in giving a proper perspective of the principles of modern genetics. The new edition should be even more useful than the first.

Within the limits set, the student of genetics and the general biologist have a very fair guide to inheritance in plants. But the field of study is enormously wide and varied and it is obviously impossible to give the substance of every recent addition to knowledge of it within the limits of one book. The student is aided by a bibliography containing about 1,500 titles and a "Key to Literature" in which the more important papers and review summaries are classified under subject headings. By means of the "Key" the uninitiated can rapidly trace the literature on, for example, twin seedlings, cotton genetics or chromatid segregation.

The predominant role in modern genetics of the cytological method is reflected in this book. Nuclear behaviour is described first, the results of pedigree breeding afterwards. This applies to each of the sections dealing with the broad mechanical aspects of heredity, namely segregation, linkage, polyploidy and structural change. The correlation achieved is rather better than that in the previous edition.

Attention is directed also towards physiological aspects of genetics. A consideration of factor interaction leads on to a useful discussion of the biochemical work on flower pigments. Later we are introduced to the balance theory of gene action and interaction.

The continued omission of any treatment of selection or of population mechanics is to be regretted. These form by far the best introduction to a study of evolution, only specialized aspects of which are covered in the present book. The evolutionary approach is principally through the results of interspecific hybridization and in relation to polyploidy and structural hybridity (especially as in *Oenothera*).

The chapter on the constitution of the gene now includes sections on the position effect, gene size estimations and the effects of X-rays. Somatic crossing-over and mosaicism in maize endosperms are also given a place here, but scarcely seem at home with the rest of the company. There is no mention of reverse mutation, and the account of the effects of X-rays is very defective and inaccurate. It is without a reference to the contributions of Timoféeff-Ressovsky, Zimmer and Delbruck on the mechanism of spontaneous and radiation-induced mutation. They have shown that a spontaneous mutation must be regarded as a chance chemical change which has a very low reaction rate and consequently a very high van t'Hoff coefficient.

A few errors have crept in. The most serious is a confusion (p. 18) between character and factor. The statement "that the immediate products of meiosis are qualitatively different in respect of one pair of alternative (allelomorphic) characters" is clearly unsound. Moreover, it contradicts the (correct) statement on p. 16 "that the chromosomes carry determiners . . . which control the transmission and behaviour of inherited characters". This tendency to a looseness of phraseology sometimes leads to an untrue statement. For example, that "Beaded wing in *Drosophila* is a dominant lethal" (pp. 69 and 275). Two of the constitutions for linkage in autotetraploids (p. 192) are wrong, namely those for asymmetrical coupling and for triplex coupling.

The final chapter evaluates the newer work on genetics. Further attack on the nature and action of the gene seems likely to lead more and more into physiological by-ways. No one can predict how advances will be made; but it is interesting to reflect that our present understanding of gene action has come from such varied experiments as the implanting of *Drosophila* eye-buds into larval abdomens, the crossing of radishes with cabbages and the regeneration of diploid moss-plants from injured capsules. D. G. CATCHESIDE.

The Claims of Logical Positivism

The Logical Syntax of Language
By Prof. Rudolf Carnap. Translated by Amethe Smeaton (Countess von Zeppelin). (International Library of Psychology, Philosophy and Scientific Method.) Pp. xvi+352. (London: Kegan Paul and Co., Ltd., 1937.) 25*s*. net.

An Examination of Local Positivism
By Dr. Julius Rudolph Weinberg. (International Library of Psychology, Philosophy and Scientific Method.) Pp. vii+311. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., 1936.) 12*s*. 6*d*. net.

THE analysis of mathematics has given rise to important schools of philosophical thought in recent years. Progress has indeed been such that it is now almost impossible to discuss certain fundamental problems of knowledge without taking into account their results. The various phases of the epic controversies between them are highly technical: hence their interest for the mathematician as well as for the philosopher.

Until recently, three irreconcilable doctrines concerning the relationship between logic and mathematics were in the field. The logistic thesis, which is illustrated mainly by the monumental work of Russell and Whitehead, makes pure mathematics a branch of logic. For the formalist school, pure mathematics is the science of the formal structure of symbols; and all inferential systems can be treated as games played in accordance with certain rules, provided the expressions used are stripped of their meaning and considered in their structural relationships. The intuitionist thinkers, who follow mainly Brouwer and Weyl, maintain that pure mathematics is founded on a basic intuition of the possibility of constructing an infinite series of numbers, with the consequence that a large portion of higher mathematics is beside the universe of logical theory.

Logical positivism goes beyond logistics and metamathematics, in considering that the logical characteristics of sentences and the logical relations between them are solely dependent upon the syntactical structure of the sentences. In this way, logic becomes a part of syntax, provided that the latter is conceived in a sufficiently wide sense and formulated with exactness.

This claim is developed technically in the standard work of Prof. Rudolf Carnap; while Dr. J. R. Weinberg's book may serve both as an introduction and as a critical analysis of the various theories connected with this new movement, which may be considered as one of the striking intellectual developments of our time. Indeed, its revolutionary character has given rise to violent controversies which still divide philosophers into rival camps.

The fundamental position of logical positivism is its stand against all forms of metaphysical or transcendental thought and expression. In this it aggravates the empirical strain which is noticeable in the works of Bacon, Berkeley, Hume and Mill. The main difference of this school from the more traditional views of logic, is that the latter are concerned not only with sentences, but also with the relations of meaning between sentences; whereas the former contends that logic has nothing to do with meaning, and is concerned only with the formal treatment of sentences.

According to logical positivism, there are only two kinds of significant statements: matters of fact, which have an empirical content and which are verifiable in principle, and necessary truths or tautologies which follow from definitions regulating the use of symbols. Outside these two kinds of statements, all propositions are meaningless, however attractive their intrinsic depth or complexity may be. What makes it difficult at first to expose the real nature of a proposition is the fact that it is usually expressed as a grammatically correct sentence; thus grammar leads to a host of verbal obscurities and pseudo-problems which, it is contended, have often passed as profound philosophical utterances. By inquiring into the meaning of propositions, confusions, paradoxes, misleading terminology which implies the existence of certain entities corresponding to words, are solved analytically and thus are given their proper value.

As Dr. Weinberg points out, logical positivism has first striven to give a careful analysis of two types of propositions: those of physical science (and their common-sense counterparts), and those of mathematics, which are shown to be reducible to logical statements free of intuition. The minute and exhaustive elucidations of concepts and expressions by Moore, Russell and various other logicians, and the outline of the work of Russell and Whitehead ("Principia Mathematica") and of Wittgenstein ("Tractatus Logico-Philosophicus") are then given a methodical and critical exposition. Dr. Weinberg shows the shortcomings of logistics, and explains how Wittgenstein's views lead to

solipsism. His treatment of probability and induction is less convincing: thus, he says that the three main types of probability are species of a simpler one, but he does not state it.

The portion of the book devoted to logical syntax forms an excellent introduction, though perhaps not a convincing one, to the standard work of Prof. Carnap, which we may, however, consider on its own merits. A word should be said, first of all, about the excellence of the translation made by Countess von Zeppelin of a most difficult and intricate text. This translation has been the occasion of improving many points of the original German work. The publishers also have spared no efforts and ingenuity in presenting such a book, with its host of complicated symbols, in a clear and attractive way.

The starting point of Prof. Carnap's system is that the distinction between the usual syntactical rules and the logical rules of deduction is that between formation rules and transformation rules, both of which are formulated, it is claimed, in syntactical terms. Prof Carnap is thus led to build up the syntax of two languages: what he calls 'language I' covers a narrow field of concepts and shows how the syntax of a language may be formulated within that language itself; 'language II' is richer in modes of expression, and helps to formulate all the sentences of classical mathematics and classical logic. In both 'languages', the investigation is not limited to the mathematico-logical part of language, but is also concerned with empirical sentences (protocol-sentences ultimately). Finally, the treatment of the syntax of these two languages leads to an outline of a general syntax applicable to any language whatsoever; though it is admitted that this attempt is very far from attaining the desired goal.

The theoretical value of these constructions is to be found in their attempt to reach the most general forms of reasoning, and to express them as adequately as possible. But such a purpose, which is apparent in the material treatment of logical syntax, is formally defeated by the adoption of the 'principle of tolerance', according to which the business of logical syntax is not to set up prohibitions, but to arrive at conventions (p. 51). Thus we are told that "everyone is at liberty to build up his own logic, i.e., his own form of language, as he wishes. All that is required of him is that, if he wishes to discuss it, he must state his methods clearly, and give syntactical rules instead of philosophical arguments" (p. 52). Now, commonsense could admit the form of such a claim, if it be made for a game. But it is difficult to allow it for the study of logic proper, which goes beyond the actual use of any specific language, whether natural or artificial.

However great the skill and ingenuity displayed by Prof. Carnap in the construction and defence of his 'languages', one cannot help questioning their practical use. For example, the artificial character of 'language I' (pp. 58–78) is shown by the fact that it introduces a number of new symbols and expressions which increase the burden of ordinary language; and that it still has to justify their meaning and use with a series of 'explanations' bristling with words of everyday usage. Again, the comparison of the primitive sentences and rules of 'language II' with those of other systems (p. 96) shows fully how relative and conventional this language II, as well as other systems, can be. The fact that 'language II' is able to give an interpretation of the fundamental notions of classical mathematics, such as the real numbers (p. 147) and classical physics (p. 149) scarcely dispels any feelings about its artificiality: for after all, it is difficult to justify an abstract construction which is totally devoid of meaning, with the simple excuse that it would provide a means of translating into a coherent system of symbols the main achievements of the positive sciences.

Such a construction might be accepted if it were final both with regard to consistency and generality, or if it could be justified on strict psychological as well as ontological grounds. But such can scarcely be the case of logical syntax, though it is bound to find outside itself the justification of its principles and development. For this reason, "Principia Mathematica" is considered as old-fashioned; and Prof. Carnap himself seems already to have moved further than the position outlined in his "Logical Syntax of the Language": there is no reason why progress should not be continuous, the more so as novelty is implied in the very process of analysis itself.

Without prejudicing the permanent logical interest of logical positivism, we cannot help thinking that the ultimate basis of its difficulties lies in its rather discouraging philosophical implications. The zest with which the extreme formalists develop their technique urges them to throw overboard the whole body of values which has so far justified philosophers in undertaking their arduous journey across the stormy seas of the mental sciences. Thus the major branches of philosophy are made to melt down to logic alone: metaphysics is bundled out into the expanse where lyrical verse already occupies a place of honour; while psychology is forced to find refuge with the empirical sciences. If logical positivism had its own way in the active field of the mental sciences, logicians alone would survive the catastrophe which would befall philosophy.

THOMAS GREENWOOD.

South-West Africa in Early Times

Being the Story of South-West Africa up to the Date of Maharero's Death in 1890. By Dr. Heinrich Vedder. Translated and edited by Dr. Cyril G. Hall. Pp. xvi+525+12 plates. (London: Oxford University Press, 1938.) 15*s*. net.

ALTHOUGH this book, originally published in German, is in name a history, the author's conception of the scope of his subject has necessitated a very full treatment of the ethnology and racial movements of the native peoples, Bushmen, Herero, Nama, Bergdama and Ovambo. Full use has been made of much valuable, but unpublished and inaccessible material, especially the remarkable collection in twenty-seven volumes of records of the "Sources of the History of South-West Africa", which has been taken into safe custody by the Administration.

The author's sifting of the material provided by his authorities is cautious and thorough. His discussion of the famous rock-engravings and cave paintings deserves attention. In the light of his experience of the native peoples, and his tests of their reactions, he is of the opinion that, while the engravings are the work of an ancient and vanished race, the paintings are relatively modern, and in all probability the work of the Bushman.

The English edition omits certain quotations of original documents, and curtails accounts of the development of certain vanished mission stations, while adding illustrations and maps. As a summary and critical account of unpublished material, the book is of considerable value to the student of the history of the South African native peoples and their relations one to another, as well as to the white man.

A Catalogue of Vertebrates of Japan

By Yaichiro Okada. Pp. vi+412. (Tokyo: Maruzen Co., Ltd., 1938.) 12*s*.

THIS valuable work presents every appearance of careful compilation to show the composition and range of the components of Japan's vertebrate fauna. It indicates, by the way, the intensity of systematic work in Japan since von Siebold's "Fauna Japonica" was completed in 1860, for the fauna at present contains 3,823 vertebrates, whereas in 1860 only 646 were known. The classes were represented now and then as follows: mammals 375 (57); birds 873 (201); reptiles 158 (18); amphibians 76 (11); cephalocorda 1 (0); cyclostomes 7 (0); fishes 2,251 (359). A rough glance through the contents shows that of non-migratory land forms, mammals, reptiles and amphibians, a very high proportion of the subspecies are peculiar to Japan and the neighbouring Korea and Formosa, whereas aquatic species and birds are more widely distributed. But it is surprising to find that among the mammals and birds only three mammals, the common house mouse, the mongoose and a deer, and three birds, are regarded as having been introduced from other countries. All the cosmopolitan rats are listed as original natives of Japan. The thoroughness of Prof. Okada's work is suggested by the extent of the index, which itself occupies 93 pages. J. R.

J. Chr. Fabricius Systema Glossatorum

Im Anhang: K. Illiger, Die neueste Gattungs-Eintheilung der Schmetterlinge aus den Linnéischen Gattungen Papilio und Sphinx; J. Chr. Fabricius, Rechenschaft an das Publicum über seine Classification der Glossaten. Herausgegeben von Felix Bryk. (Sammlung naturwissenschaftlicher Facsimile-Drucke, Band 1.) Pp. xii+112+13+4. (Neubrandenburg: Gustav Feller, 1938.)

THE "Systema Glossatorum" was the last work of the great Danish taxonomist, J. Chr. Fabricius, and is of fundamental importance to those who are concerned with the nomenclature of butterflies. It is, furthermore, a publication of the greatest rarity, and apparently only two examples exist of the original in the Latin language (1807). The present work reproduces in facsimile the original text of Fabricius, which is thus now rendered accessible to all and sundry who are concerned with taxonomy. As supplements there are also included facsimile reproductions of Illiger's "Gattungs-Eintheilung der Schmetterlinge" and Fabricius's brief *Rechenschaft* of his classification of Glossata. A. D. I.

Faunistischer Führer durch die Coleopteren-Literatur

Die wichtigste Käfer-Literatur nach geographischen Gebieten geordnet. Von S. Schenkling. Band 1: Europa. Lieferung 1. Pp. 64. 6 gold marks. Lieferung 2. Pp. 65–128. 6 gold marks. (Neubrandenburg: Gustav Feller, 1938.)

THIS work aims at being a guide to the more important faunistic literature on the Coleoptera, which is arranged according to the geographical regions. Volume 1, it is announced, will consist of about ten *Lieferungen* and these are concerned with the general Palæarctic region and with Europe. Volume 2 is to treat of the literature referring to palæarctic Asia and Africa together with the Indo-Malayan region; Volume 3 with Ethiopia, Australia and Oceania and Volume 4 with America.

A specialized work of this kind should prove a valuable aid to the taxonomist and especially to students in the great museums. A survey of the two parts already published makes it evident that this "Führer" will simplify the task of searching the literature in any particular group of these insects inhabiting a specified country or region.

Einführung in die theoretische Physik

Von Prof. Dr. Clemens Schaefer. Band 3, Teil 2: Quantentheorie. Pp. vii+510. (Berlin und Leipzig: Walter de Gruyter und Co., 1937.) 26 gold marks.

THIS substantial volume forms one part of a comprehensive "Introduction to Theoretical Physics" written by Dr. Schaefer of Breslau, and is concerned with quantum theory, treated mainly from a mathematical point of view. About one half of the book relates to the theory of Bohr, for the author considers that this is historically correct and also represents the best approach to wave mechanics. The final chapter deals with Dirac's theory of the electron and positron.

Plastics and Some Recent Applications

By H. V. Potter

CONSIDERABLE progress has been made in the practical application of plastics in every sphere since the author's review which appeared in NATURE of March 9, 1935. Moulded radio cabinets were then just being introduced, and these were regarded as a great step forward since they represented by far the largest mouldings which had at that time ever been made. The advent of these large mouldings meant far more than capturing the radio cabinet market. Their introduction entailed the installation of larger and more powerful presses in moulding works, and once presses of this type had been purchased efforts were made to find uses for them, and larger mouldings followed as a natural corollary.

Probably the largest mouldings ever made are the standard-sized coffins or caskets which are now in experimental production. These require a press of approximately 4,000 tons capacity, and each casket uses nearly 95 lb. of moulding material in its production. Although the consistent increase in size of mouldings is an indication of progress, improvement is primarily noticeable in the materials from which the mouldings are produced.

It is proposed to confine attention in this review to those synthetic resinous plastics which have already attained an important position in industry. A brief perusal of the patent literature will disclose that hundreds of new plastics have been proposed in recent years, most of which will progress no farther than publication of the patent. From the industrial point of view, the two most important synthetic resins are the phenol-formaldehyde and urea formaldehyde types, both of which are thermo-setting. From each of these, moulded materials and laminated materials are produced, while they are also employed in paints and varnishes in place of natural resin.

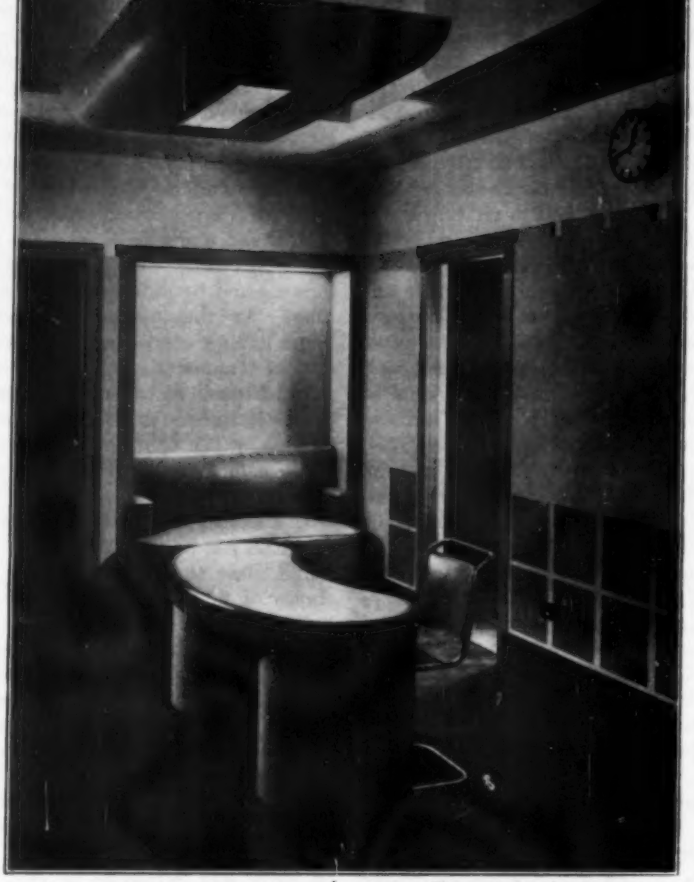
A brief outline of the manufacture of phenol products—better known, perhaps, as 'Bakelite' materials—may assist those who are not familiar with the process. Basically, the production of urea materials, once the resinoid has been made, is similar to the methods adopted for manufacturing phenolic moulding powders and laminated sheet.

By mixing phenol and formaldehyde in a heated reaction vessel together with a suitable catalyst, a reaction occurs which results in the formation of a heavy viscous mass at the bottom of the vessel with a layer of water above it. When the upper layer has been removed by evaporation, the remaining material is tapped off and allowed to cool. It is then a brittle, amber-like solid which can be softened by heating. Continued application of heat, however, causes this 'resinoid', as it is termed, to become permanently hard and insoluble. Moulding powders are made by pulverizing the initial resinoid and mixing with it various fillers, pigments, mould lubricants, plasticizers, etc. The ultimate result of this processing is a powder from which the moulder produces the finished moulding by charging pre-determined quantities into heated steel moulds which are then closed under pressure. The properties of the mouldings can be varied by changes in the resinoid formula and by differing types and proportions of filler. In this manner the moulding material manufacturer can ensure, within limits, that any desired characteristic shall be present in the finished moulding. Good dielectric properties, low power losses at very high frequencies, resistance to heat, water or chemicals are typical examples of the many grades of material which have been developed to meet some specific requirement.

In a similar manner, the properties of laminated materials can be varied, but within much narrower limits, since the manufacturer is restricted in his choice of fillers. These laminated materials are built up by impregnating sheets of paper or fabric with resinoid and forming many such sheets into a solid board under heat and pressure. The material is produced ranging from a few thousandths of an inch in thickness for some types of electrical insulation up to a maximum thickness of 4 inches for gears. Yet another grade of laminated material is employed for decorative purposes. Veneers and wall panels are now in regular production and are used for the surfacing of walls and furniture in the home, hospitals, offices, hotels, restaurants and all types of public buildings. A surprisingly wide range of beautiful colours—pastel shades, black, white, mottles and wood grain patterns—is available, and the materials also embody unusual and valuable properties. They are unaffected by steam or moisture and are resistant to heat, fruit-juices and alcohol. Their surface does not corrode and, being non-hygroscopic, is hygienic and easily kept clean.

The range of present-day uses of plastics is so wide and so important that it is impossible fully to describe their applications in the space of this

article. Since engineering uses are now very much to the fore, some of the more interesting developments in this sphere will be outlined. The aircraft industry finds many uses for plastics. Phenol plastics are mechanically strong and their weight is only half that of aluminium. This fact, combined with the ease with which moulded parts can be produced, provides a tempting prospect for the aircraft engineer, and it is reasonably certain that moulded fuselages, wings, etc., will be pressed out of plastic material in the not too distant future. The size of mouldings has hitherto been a drawback but, as mentioned earlier, moulded coffins have been made and moulded sheets of laminated paper and wood have been manufactured up to 20-ft. in length. For large structures, such as an aeroplane fuselage, wood reinforced with synthetic resins has an important future. The latest developments here follow closely along the lines of laminated material practice, that is, veneers of wood are treated with 'Bakelite' resins, built up into boards of required size and consolidated under heat and pressure.



APPLICATION OF PLASTICS IN DECORATIONS. THE WALLS AS WELL AS THE DESK ARE SURFACED WITH 'BAKELITE' VENEERS.

Another recent development is the moulded airscrew blade shown in the photograph opposite. This is probably the largest moulding yet made in which continuous lengths of fabric have been used. The threads at the root end forming the flange are unbroken throughout the whole length of the blade except where necessitated by the gradually decreasing cross-section. A core is accurately located in the centre of the blade and around this the reinforced material is moulded and compressed. A high-frequency furnace is employed to melt the core metal without damaging the blade.

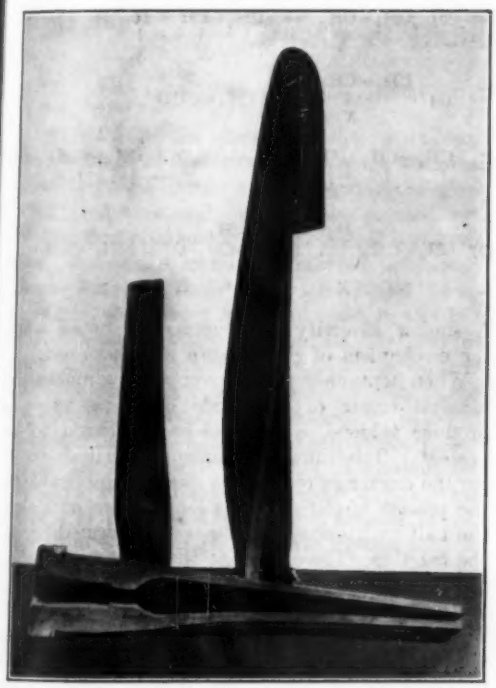
An organic glass, obtained from methyl methacrylate, which is one of the thermoplastic resins, is replacing ordinary glass for wind shields, observation turrets, etc., in aircraft. It is light in weight, has a good refractive index and will not splinter on impact.

Many small components in aircraft construction are produced from plastics, including barrel supports for variable pitch airscrews, shims, chafing rings, etc. There is no doubt, too, that if a synthetic resin having much greater physical strength and elastic property could be developed, the field of application for plastics would be far wider. Research is continually proceeding in an endeavour to attain this object, and it must eventually be achieved. The limit has almost been reached for increasing the mechanical strength of plastic materials by differing types of filler.

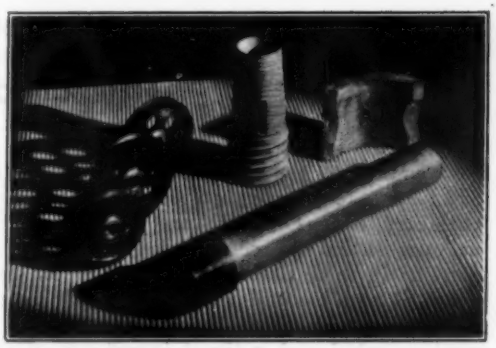
Synthetic resins have made possible a great improvement in plywood, which is of particular importance for aircraft work. Phenolic resins incorporated on paper are employed as the

adhesive for the various plies of a plywood board. The paper is of tissue thickness and is merely a vehicle for providing a resin film in convenient form. The plies with the impregnated paper interleaved between them are formed into a solid board in a hot press, the heat causing the resin film to flow, penetrating the wood and finally polymerizing. In contrast to ordinary plywood glues, the strength of the synthetic resin bond is actually increased by immersion in water. This remarkable water resistance, and the fact that the adhesive is impervious to insects and fungus, greatly enhances the prospects of plywood for aero construction.

Two important applications of phenolic laminated materials in engineering are for the production of gears and bearings. The material is easily machined by standard workshop methods, and gears transmitting up to 300 h.p. are now made from it. One or more of these plastics gears in a gear train results in a considerable reduction of noise and they have other advantages due to their chemical resistance. Wherever bearings of phosphor bronze, white metal or lignum vitæ have been used previously, consideration may advantageously be given to the synthetic resin bearing. Far longer life is frequently obtained and the sole lubricant required is water. The material is not, of course, suitable for use for components in high-speed engines.



A HOLLOW MOULDED BLADE FOR A VARIABLE PITCH AIR-SCREW, 6 FT. FROM CENTRE TO TIP.



CONTROL PULLEYS, BARREL SUPPORT AND UNDER-CARRIAGE PISTON USED IN MODERN AIRCRAFT, MACHINED FROM PHENOLIC LAMINATED MATERIAL.

The applications of plastics to-day are extraordinarily diverse. Thousands of mouldings are made daily and are used in almost every industry. More than seven million insulating components punched from laminated material may be used in a single telephone exchange. Matrices for printing stereos are made from a phenolic material, dentures are made from the pure resinoid, and, in the form of lacquers, varnishes and cements, synthetic resins are assisting industry in many ways. Yet despite the progress which has been made in the past four years, it is not too optimistic to forecast that progress in the next four years will be even more rapid.

The resins more recently developed, such as vinyl and polystyrene, are slowly making headway for uses to which they are better suited than the earlier resins. These materials can be moulded by the injection process, that is, forcing the resinoid (which has previously been plasticized by heat) through an orifice into a closed mould, in place of the older method of using the resinoid in powdered form. The vinyl and polystyrene resins have valuable properties some of which are not possessed by the other resinoids. They have a water-white transparency, good electrical properties and excellent water resistance. They are, however, thermoplastic and can, therefore, be softened repeatedly by heat while, as already noted, the phenolic and urea resinoids are permanently hardened by heating.

There has been a good deal of development in connexion with the equipment for injection moulding, and machines are now available which work almost automatically except for switching on the electric current and keeping the feeding hopper filled with the resinoid. Further important advances in the mechanization of press operations will undoubtedly be seen in the future.

Hydrocarbons in Industry

SINCE the structures and classical methods of synthesis of the aliphatic hydrocarbons serve as an admirable introduction to systematic organic chemistry, it is perhaps natural that these early chapters should be soon ignored and then forgotten. In those countries, however, fortunately endowed with natural sources of liquid hydrocarbons, their chemistry has become a subject of vital technical and national importance, whilst countries which have to rely on imported or synthetic products are even more dependent on methods by which cheapness of production and economy in utilization of fuels of high octane number or of lubricants can be achieved.

A general discussion was held by the Faraday Society on April 17–19 at the Imperial College of Science and Technology, London, under the title "Hydrocarbon Chemistry", with the object of ascertaining how far present scientific inquiry into the reactions of the hydrocarbons could serve in interpreting the somewhat complex processes already operating in industry. The discussion divided itself naturally into four sections: homogeneous thermal reactions, catalytic reactions, synthetic hydrocarbon production and, finally, olefine polymerization.

It is admitted that the mechanism of the thermal cracking process is a complicated one, but that it involves chain mechanisms at some stage, a hypothesis first advanced by Prof. R. O. Rice and now generally accepted. There is, however, no unanimity of opinion as to the actual chain processes involved in the reactions. Hydrocarbon free radicals can be prepared by a variety of methods and their properties have been described. It has also been shown that they can initiate chains of reaction when admitted to the saturated hydrocarbons at suitably elevated temperatures. Much of the discussion centred around the questions as to how the reaction centres originate, what were the relative rates of such reactions as

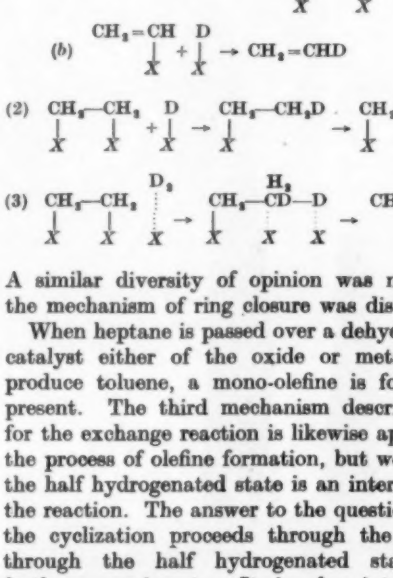
$$H + C_2H_6 \rightarrow H_2 + C_2H_5,$$
$$H + C_2H_6 \rightarrow CH_4 + CH_3,$$

and

$$H_2 + CH_3 \rightarrow H + CH_4,$$

and by what mechanisms admission of nitric oxide cuts down the velocity of decomposition.

From the technical point of view, the problems to be solved in connexion with the synthesis of fuels such as iso-octane or aromatic hydrocarbons are how to utilize two straight-chain hydrocarbon fractions, one from C_3–C_5 and the other from C_1–C_4. It appears clear that owing to the high temperatures involved in thermal cracking, which leads to loss of control, the method of attack by thermal decomposition of the C_5–C_9 fraction to C_3–C_4 and resynthesis of isoparaffins is not in favour, and alternative methods are being sought. Three avenues of attack on this problem are being explored, each involving catalytic reactions. The most direct involves catalytic cracking to a C_3–C_4 fraction followed by resynthesis of isoparaffins, the second catalytic ring closure, and the third attempts to bring about directly catalytic isomerism to isoparaffins as has already been found possible in the shorter members of the series. The discussion made it clear that the *modus operandi* of any one of these processes is by no means clear. This is exemplified by the fact that in one of the simplest reactions, namely, the exchange reaction of deuterium with an unsaturated hydrocarbon, such as ethylene, or a saturated one, such as ethane, three different mechanisms have been advanced. These may be depicted as follows:



A similar diversity of opinion was noted when the mechanism of ring closure was discussed.

When heptane is passed over a dehydrogenating catalyst either of the oxide or metal type to produce toluene, a mono-olefine is found to be present. The third mechanism described above for the exchange reaction is likewise applicable to the process of olefine formation, but we note that the half hydrogenated state is an intermediary in the reaction. The answer to the question whether the cyclization proceeds through the olefine or through the half hydrogenated state awaits further experiment. It is also interesting to observe that both (2) and (3) provide us with mechanisms by which the double bond in an olefine can travel towards the end of the chain, so

that cyclization may result. Cyclization in the gas phase involves a large change in entropy, since the difference in the internal mobilities of the straight chain and ring is so pronounced; it is clearly important to devise some method by which the position of the molecule adsorbed on the catalytic surface at the temperature of ring closure may be examined.

On the synthesis side, discussion was devoted to the interesting reaction which occurs between a saturated tertiary hydrocarbon and an olefine in the presence of a variety of catalytic agents, especially sulphuric acid. Whilst considerable progress has been made in elucidating the structure and energies of reactions involving conjugated double bonds, it would be very desirable if calculations on reactions of the type

$$D + CH_4 \rightarrow CH_3D + H,$$
$$D + CH_4 \rightarrow CH_3 + HD,$$

were made. In the technical synthesis of liquid fuel, it is clear that processes of coal hydrogenation are extremely complex and that the identification and examination of the various reactions involved would be a matter of great difficulty. Whilst very complex products can be made by the Fischer–Tropsch process, the initial reactions which the carbon monoxide and hydrogen undergo in building up the complex hydrocarbons are much simpler, and some success has already been achieved in identifying and examining the successive reactions which are involved. It was clear from the discussion that it may be possible to synthesize many other products in addition to the straight-chain hydrocarbons by means of this elegant reaction.

The last section of the discussion was devoted to the polymerization of the olefines. Here dimerization of short-chain olefines to produce fuels, and polymerization to produce long-chain macromolecules suitable for plastics, are at present the two important technical objectives. No less than nine papers were devoted to this aspect of hydrocarbon chemistry.

The Faraday Society always attempts to emphasize the international character of its discussions on scientific subjects, and it is worthy of comment that this meeting was a truly representative one in spite of the present political situation.

ERIC K. RIDEAL.

Growth of Induced Plant Tumours

By László J. Havas, Institute of Pathological Anatomy, Brussels

A COMPARISON between the malignant tumours of animals and the plant tumours, commonly called 'crown gall', is beyond the scope of the present article*. It may be pointed out, however, that characteristic histological and cytological differences can be observed—obviously enough—between these two pathological structures, such differences being inherent in the two types of host organisms themselves. It may be added further that the analogies of response of plants and animals, to be described, were obtained *in spite of* their structural differences.

Inspired, no doubt, by the experimental induction of tar tumours in animals, discovered by Yamagiva and Ichikawa, Komuro[1] exposed the root tips of *Vicia Faba* and *Pisum sativum* to suspensions of coal tar. He obtained by this method well-characterized neoplasic structures termed by him 'phyto-tartumours'. Most of the cellular abnormalities described by Komuro in these swellings, such as giant and multinucleate cells, plurinucleolated, lobed, vacuolized and fragmented nuclei, amitotic divisions, chromosome aberrations, etc., were also observed by Mottram, Picon, Levine and Bergmann[2] and others, in onion and bean roots treated with coal tar and also with Scharlach Red. Such effects, as the systematic investigations of Levine[3,4] and Chargaff[5] have shown, were not limited to the particularly sensitive root tips, for swellings macroscopically comparable to crown gall, and presenting similar cytological abnormalities, were also produced by them on the stems of the most heterogeneous annuals, and even woody plants, subjected to local treatments (painting) with the above and a variety of other chemicals.

The discovery of the active factors in coal tar responsible for tumour production in animals (Bloch and Widmer), and the isolation and synthesis of these and other highly carcinogenic hydrocarbons (Kennaway; Clar; Cook *et al.*[6], Fieser, and others), gave an added impetus to the study of the etiology and of the experimental induction of chemical cancers in animals. One of these compounds, 1 : 2 : 5 : 6 : dibenzanthracene, was tested by Levine[3], and was shown

* See for reference on this subject the excellent review of A. J. Riker and T. O. Berge, *Amer. J. Cancer*, **25**, No. 2, 310–356.

to produce marked overgrowths when applied locally (painting) on the stems of a great variety of plants. A similar application of benzpyrene and of methylcholanthrene provoked, however, only an unlocalized thickening and bending of the stems of roses and tomatoes (Havas), although the carcinogenic potency of these compounds is known to be far superior in animals to that of dibenzanthracene. On the other hand, a definite increase in the size of the neoplasms was observed by Havas[7] when crown gall tumours of the tomato were painted with benzpyrene at an early stage of their development. Such divergencies are natural, as the degree of sensitivity of different plants, and even of individuals within the species, varies in a great measure[3,4].

But the faculty of inducing neoplasms in plants is not limited to the above-mentioned polycyclic hydrocarbons. Thus, Auler[6] was able to demonstrate that lactic acid also has such properties, while the role of this substance in the carcinogenic sensibilization of animals was shown by Parventjev[9] and others. The influence of the different amino-acids on the development of the tar tumours and the spontaneous tumours of rodents has been studied by a great number of workers (Vles[10], Coulon, Suzuki[11], etc.). While some of these acids seem to inhibit cancerous growth, *l*-cystine and glutamic acid are generally regarded as carcinogenic sensitizers[11] in animals. An analogous effect of these two chemicals is reported by Levine[5], who induced by their local application neoplasms in plants. Similar parallelisms of action were obtained by such widely different organic and inorganic substances as copper, alcohol, ethylene, etc[4,5].

While in the preceding examples the method of the experimental approach to the problem consisted in the attempted *induction* of tumours in normal plants, the experiments to be reported now were designed to test the effects of the various carcinogenic and carcinolytic sensitizers of animals on the incremental *growth* of plant tumours already induced by inoculating the plants with *Bacterium tumefaciens*, the causal agent of 'crown gall'. The technique applied in these experiments was also different, the substances having been introduced (unless otherwise mentioned) directly through a cut in the stem or through a petiolar stump, using the negative pressure in the water stream to pull up the solutes in the plants[12].

The carcinogenic power of the œstrogenic hormones seems to be now rather convincingly established in animal experiments (Leo Loeb[13], Lacassagne, Fodor *et al.*[14], Gardner, McEuen, and others). Comparable effects of the follicular hormone were shown by Havas[15] on the incremental growth of the crown gall of the tomato, an increase in the weight of the tumours, amounting to 70–80 per cent, having been obtained as a result of this treatment. The stimulating effect of this hormone on the tumours of the tomato was also observed by Stapp[16]; but on *Ricinus*, and using a different mode of administration, Verona[24] was unable to confirm such an action. Although apparently less active than the follicular hormone, an increase in the weight (23 per cent) of the above phytocarcinomata could also be recorded by treatments with the hormone of the anterior lobe of the pituitary (Havas).

The experimental evidence furnished by the majority of workers (Fodor[14], Hayashi[17], Engel[18], Reiss *et al.*[19], Jones, and others) seems to confirm the similarity of action of this endocrine product in animals. The role of the active principle of the thyroid gland in the carcinogenic sensibilization of animals is still under discussion (Suzuki[11], Engel[18], Forsell, Jones, and others). It may be mentioned, however, that a definite increase (37 per cent) in the weight of the above neoplasms of the tomato was obtained under the influence of thyroid extracts[12]. Effects to the contrary, namely, a 20 per cent reduction in the weight of the tumours, were also observed by Havas[12] on plants treated with the hormone of the thymus gland, which according to Engel[18], Arzt, Fichera, and others increases the cancer resistance of animals.

In spite of the many contradictory views expressed by cancerologists as regards the influence of the different vitamins on malignant growth (Gordonoff and Ludwig[20], Caspari, Biseglie, Geréb, Fodor and Kunos[21], and others) there is now fair agreement that an excess in the vitamins C and A increases the receptivity of animals to cancer. Vitamin C was tested by Havas[22] on tomato plants, inoculated as above, and it was found that the weight of the tumours exceeded by 29 per cent that of the controls. Still more striking were the results obtained with the vitamins A and D tested on a variety of *Opuntia* which, after several hundred inoculations, had proved to be highly immune to *B. tumefaciens*, as only about 1·5 per cent of the inoculations have taken. When, however, the site of the inoculations was painted with solutions of vitamin A or D, 80 per cent of the inoculations yielded large intumescences[7,12].

Colchicine, which has come recently to the fore, thanks to the important investigations of A. P. Dustin[23], was shown to have encouraging carcinolytic properties by Dustin and Amoroso. Peyron[24] claims even a "complete sterilization" of the experimental and spontaneous tumours of different animals. A parallel action of this alkaloid was described by Havas[12] on the growth of the crown gall of the tomato, the weight of the neoplasms of the treated plants having been reduced to half that of the controls.

Finally, an example may be given when the discovery of a carcinolytic substance of plants has preceded the experimental evidence of the similarity of its action in animals. This agent is the sap of the mistletoe (*Viscum album*) which, according to the mode of its extraction and administration, produced tumour resolutions ranging from 66 to 5,000 per cent on tomato and *Ricinus* plants (Havas[7]). But no clear-cut results were obtained by the author in animal experiments. Thanks to an apparently more adequate preparation of the *Viscum* sap, Koch[25] could report, however, a surprisingly high percentage of amelioration and complete healing of the Ehrlich tumours of the mice.

In conclusion, it seems desirable to emphasize that, in spite of the suggestive analogies of response described, the *specificity* of action of the agents responsible for such reactions is by no means suggested. The diversity of the chemical structure of the substances used and the fact that similar parallelisms of response can be obtained by purely physical intervention speak for themselves against such a concept. The connecting link between the phenomena observed is, therefore, more likely to be found in analogous endogenous factors present in both the animal and plant protoplasms.

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Obituary Notices

Prof. W. Cramp

THE sudden death of Dr. William Cramp, at Llandudno on April 20, at sixty-three years of age, will be a severe blow to his many friends and especially to his old students at the University of Birmingham. He had a great gift of sympathy with his students. He readily understood their difficulties, took great pains to clear them up and so endeared himself to them all.

Cramp was educated at King Henry VIII Grammar School, Coventry, and at the University of Manchester. From 1892 until 1897 he served his apprenticeship with Rotherham and Sons, Coventry, and from 1897 until 1901 was an engineer with Ferranti, Ltd., Hollingwood. At the age of twenty-five he was appointed lecturer in electrical design at the Central Technical College, South Kensington, under Prof. Ayrton. He then set up in practice as a consulting engineer in London and Manchester, giving, at the same time, lectures to his old University. In 1908 he was transferred to full membership of the Institution of Electrical Engineers; he communicated many papers to it and was awarded several premiums for them. During the Great War he was twice commissioned to do special work for the Board of Trade in Italy. In 1919 he was appointed professor of electrical engineering at the University of Birmingham, where he did much valuable research work. He always enjoyed showing his friends the original work that was being done in the laboratories under his direction.

Cramp took an active part in the meetings of the British Association. In his presidential address to Section G at Blackpool on "The Engineer and the Nation", he took a sombre view of the world as a whole and of the little recognition given to the work done by the engineering profession. He controverted the popular criticism of the use made of scientific discoveries for war purposes. He stood as a devotee of pure science that had no moral obligations and no ethics. If the engineer were left undisturbed by the politician, he visualized the power he might exert to make war impossible. A few months later, Prof. Cramp lectured before the Royal Institution on the future of power supply, and he pointed out some of the difficulties that would have to be overcome before the 'grid' system of supply could be regarded as ideal. In 1931 Prof. Cramp gave the Faraday Lecture to the Institution of Electrical Engineers at London and at several of the local centres, the subject chosen being "Faraday and his Contemporaries".

Several treatises which have proved useful to students of engineering were written by Prof. Cramp; in particular, his books on "Armature Windings", "Continuous Current Machine Design", and, in conjunction with C. F. Smith, "Vectors and Vector Diagrams". He also contributed many scientific papers to various journals.

He was the inventor of the 'Cramp single-phase motor', a self-exciting alternator, apparatus for the production of nitric acid from the air, and a new system of coal-face lighting. It was only a few weeks

ago since his special knowledge of the use of electricity of mines was recognized by his appointment to the chairmanship of the committee set up by the Secretary of Mines to consider what amendments are required to the general regulations governing the use of electricity in mines under the Coal Mines Act, 1911.

Cramp took an active part in the activities of the British Broadcasting Corporation. He was largely responsible for founding the Engineering Club in Manchester in 1913 and the 'Children's Concert Society' in Manchester in 1914. His interests were very wide and he had been looking forward to many plans for the future when the end came. He was a widower and leaves two daughters, to whom the sympathy of his many friends will be extended.

Prof. F. J. Cheshire, C.B.E.

THE death of Prof. Frederic John Cheshire, on March 24, at seventy-eight years of age, removes one who had a very considerable influence on the development of the optical instrument industry in Great Britain, more especially during the War of 1914–18 and in the following years. His main interests lay in the fields of experimental science, and his true vocation was to the life of a teacher.

Cheshire was born on June 8, 1860, being the son of the late Mr. George Cheshire of Leeds. He was educated at Birkbeck College, and at the Royal School of Mines. After some early training in engineering at the works of Messrs. Greenwood and Batley, Leeds, he entered the Customs and Excise Service in 1880, and thence went to the Government Laboratory as a chemist. In 1885 he secured an appointment by open competition on the examining staff of the newly instituted Patent Office, where he served until 1915, when he was transferred to the Ministry of Munitions and became deputy director-general of the Optical Department. On the formation of the Optical Engineering Department at the Imperial College in 1917, he accepted the post of director, and held this position until his retirement in 1925. He was awarded the C.B.E. in 1918. Even this busy career had not exhausted his abundant energies, and he afterwards acted as consultant to various commercial firms.

In the course of his early teaching work, Cheshire became well known for the interesting experiments with which his lectures were illustrated. He had a great desire to give practical assistance to students from industrial firms, and on one occasion had been invited to give a course of lectures on sound under the auspices of the London County Council for the benefit of workers in piano factories. At the beginning of the course he was asked, "What do you know about making pianos, Mr. Cheshire?" "Nothing at all," he replied, "but I do know some things which every maker of pianos should know."

With this outlook, it is natural that Cheshire's main publications were concerned with the improvement of apparatus for teaching and lecture demonstration. Early papers described optical projection apparatus of an improved description including a polariscope. He also took much interest in the design of microscopes, especially petrological types, and apertometers. His papers appeared generally in the *Transactions of the Optical Society* and the *Journal of the Royal Microscopical Society* between 1907 and 1923. In 1917, it was difficult to purchase teaching apparatus, and he designed various ingenious optical benches and similar apparatus which could be constructed in the College workshop, in addition to sundry pieces of apparatus of an original character, including 'focometers' and 'squaring-on eyepieces' for the equipment of the laboratories.

Cheshire insisted that technical optics was essentially a branch of engineering, and changed the name of the section to the "Optical Engineering Department". He considered that the mechanical design of instruments needed attention, and the provision of instructional courses, equally with purely optical design. His experience at the Patent Office and contacts with the staff of Messrs. Carl Zeiss had, however, shown him the importance of thorough-going computational work in optical design, and the appointments made to his teaching staff reflected these ideas.

Cheshire was a man of charm, and had a natural capacity for leadership. From 1916 until 1920 he was president of the Optical Society, and in 1922–24 president of the Royal Microscopical Society. He was a founder fellow of the Institute of Physics. He was a sportsman of parts, and designed a well-known golf-club. In 1886 he married Mary, daughter of the late Mr. George Richardson of Huddersfield, and had a son and a daughter.

PROF. FRANTIŠEK NACHTIKAL, a distinguished Czech physicist, died in Prague on April 12 at the age of sixty-five years. He was the author of several monographs on electrotechnics and applied physics. He served on the Czechoslovak patents council and was an authority on wireless transmission and technology.

WE regret to announce the following deaths:

H. Coote-Lake, treasurer of the Royal Anthropological Institute, on April 22, aged sixty years.

Dr. Marguerite Kettle, assistant editor of the *Lancet*, widow of Prof. E. H. Kettle, F.R.S., on May 4, aged fifty-one years.

Mr. Henry Marsh, C.I.E., known for his engineering work, especially in connexion with irrigation in India and South America, on April 25, aged eighty-eight years.

Engineer Vice-Admiral Sir Henry Oram, K.C.B., F.R.S., formerly engineer-in-chief of the Fleet, past president of the Junior Institution of Engineers and of the Institute of Metals, on May 5, aged eighty years.

Prof. C. S. Plumb, emeritus professor of animal husbandry in the Ohio State University, on March 4, aged eighty-eight years.

Mr. Daya Ram Sahni, C.I.E., formerly director-general of the Archæological Survey of India, aged sixty years.

NATURE

SUPPLEMENT

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LETTERS TO THE EDITOR

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR AT P. 811.

NUCLEAR PHYSICS

Control of the Chain Reaction involved in Fission of the Uranium Nucleus

IT has recently been shown that the number[1] of neutrons liberated[2] in the nuclear fission of a uranium nucleus is sufficiently high to make the realization of a self-perpetuating reaction chain seem possible. The danger that a system containing uranium in high concentration might explode, once the chain is started, is considerable. It is therefore useful to point out a mechanism which gives the possibility of controlling the development of such a chain.

We form an expression which is characteristic for the behaviour of the chain:

$$\nu'' = \frac{A_f}{A}\nu(1-\alpha), \quad . \quad . \quad (1)$$

A_f being the product of the cross-section for nuclear fission for a thermal neutron of the uranium nucleus with the concentration of the uranium; A_i the product of the absorption cross-section for thermal neutrons of the nucleus of kind i multiplied with its concentration; A the sum of all A_i's, which is to be taken over all kinds of nuclei present in the solution; ν is the average number of neutrons liberated in one fission, α the average probability for a neutron to diffuse out of the system before being absorbed.

The energy liberated by the chain will be

$$E = NF, \quad . \quad . \quad (2)$$

F being the energy liberated in one fission and N the number of fissions produced by the chain. We have

$$N = \nu'' + \nu''^2 + \nu''^3 + \ldots\ldots . \quad (3)$$

The chain gives thus a quantity of energy, which is increasing rapidly with time, if ν'' is greater than 1. Let us consider the case of a chain which is due to fission produced by thermal neutrons; that is, a chain propagating itself in a system containing sufficient hydrogen for the slowing down of the neutrons.

If the cross-sections for capture or fission of all nuclei present follow the $1/v$ law, ν'' will not depend on the velocity of the neutrons and therefore not on the temperature of the system (since α will in practice be small and since it depends in the first place on the distance necessary for slowing down the neutron; the temperature has, of course, an effect, although it will be very small).

Let us, however, introduce an absorbent, such as cadmium, the cross-section of which does not depend on the neutron energy in the thermal region. We will have, instead of (1),

$$\nu'' = \nu\frac{A_f}{A' + A_c}(1-\alpha), \quad . \quad . \quad . \quad (4)$$

where A' is the sum of all A_i's following the $1/v$ law and A_c is a constant, the term due to the newly added absorbent. ν'' will now decrease with increasing temperature. At a temperature, which will be characteristic for the composition and the geometrical constants of the system, ν'' will become smaller than unity and the system will stabilize itself somewhere near this temperature; the equilibrium being determined by the fact that the amount of energy given out per unit of time by the system (in the form of heat and nuclear radiation) is equal to the energy produced by the system. Similar questions have been discussed by F. Perrin[3].

Added in proof: In the case of a chain propagating itself by thermal neutrons, the time necessary for the slowing down and for the absorption of a neutron, that is, its mean life, is of the order of 10^{-4} sec. If one makes ν'' as small as 1007, it needs 100 times the mean life of a neutron or about 10^{-2} sec. to double the number of neutrons, and with that the energy liberated per unit of time. It is therefore possible to control the development of the chain by a periodical interaction of absorbers which break up the chains by entering the system.

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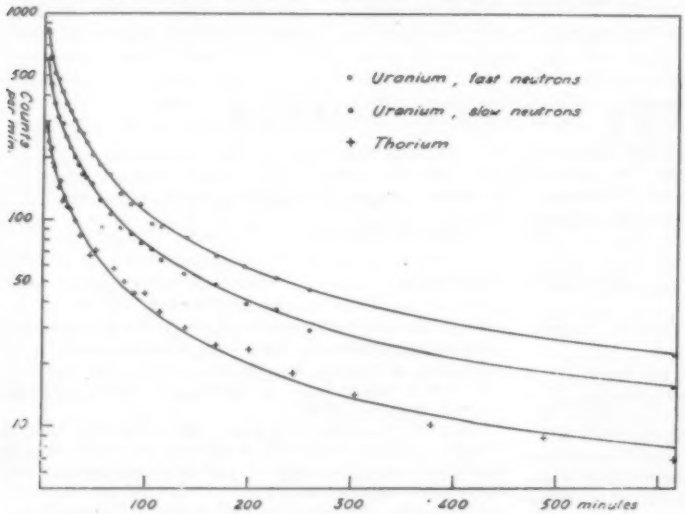
Decay Curves of Uranium and Thorium Fission Products

It has been suggested by Bohr[1] that the rare isotope $^{235}_{92}U$ is responsible for the fission produced in uranium by slow neutrons, while the fission produced by fast neutrons is to be ascribed to the abundant isotope $^{238}_{92}U$. In this connexion it is of interest to see whether any differences can be detected between the shapes of the resulting decay curves for the fission products of uranium bombarded with fast and slow neutrons, and also to compare these curves with those obtained with thorium. Some experiments by F. Joliot[2] indicated that slow neutrons were relatively more effective in producing the longer period activities than the shorter.



Decay curves for the disintegration of uranium by fast and slow neutrons, and for the disintegration of thorium

We have made similar experiments using neutrons from a lithium target bombarded with 50 micro-amperes of 750 kilovolt deuterons. The fission products were collected by recoil on a collector plate placed 1 mm. below a glass plate painted with uranium or thorium oxide. In the fast neutron experiments, these plates were surrounded with cadmium sheets and placed immediately below the lithium target. In the slow neutron experiments a 4 cm. slab of paraffin wax was interposed between the target and the plates, which were resting on another block of paraffin wax, 8 cm. thick. In the latter case 75 per cent of the activity obtained was due to slow neutrons (only 25 per cent remaining when the plates were shielded with cadmium).

In three series of experiments, uranium was bombarded for 20 seconds, 3 minutes and 100 minutes, respectively, care being taken to keep the neutron intensity constant during the irradiation. In the first two cases the collector was of lead, while in the 100-minute experiment paper was used. Afterwards the activity of the collector plates was measured with a Geiger counter connected through a Neher-Harper circuit to a 'scale of eight', which had been tested for linear counting up to 5,000 particles per minute. The accompanying graph shows the decay curves obtained with 100 minutes exposure; each curve represents two series of measurements. The shape of the curve is the same for fast and for slow neutrons. This was also the case in the experiments with 3 minutes exposure and 20 seconds exposure, where several series of measurements were taken and the decay was followed for 30 minutes and 5 minutes respectively. In no case did the ratio of the activity for fast and slow neutrons change during the decay; a change of 10 per cent would have been noticed.

As regards the thorium fission products, the shape of the decay curve is again indistinguishable from that of the uranium fission products for the same time of exposure. In order to avoid contamination with the active deposit from thorium emanation, the thorium oxide layer was sealed up behind a celluloid foil of 0·4 mm. air equivalent. In the case of the 100 minutes exposure this was, however, not sufficient, and only when the emanation was continuously blown away during the exposure was this contamination avoided.

From the measurements just reported, it thus seems impossible to decide whether different uranium isotopes are responsible for the fission produced by slow and fast neutrons. Although some of the periods for the fission products from different nuclei must be different, the abundance of periods of any duration seems to be so great that these differences are smoothed out in the resulting decay curve.

We wish to thank Prof. Niels Bohr for suggesting the problem, and Prof. L. Meitner and Dr. O. R. Frisch for help and advice.

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K. J. Brostrøm.
J. Koch.

Institute of Theoretical Physics,
University of Copenhagen.
May 2.

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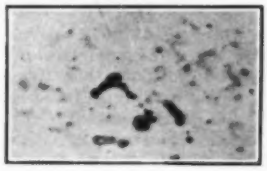
Tracks on Photographic Plates of the Recoil Nuclei of Disintegration of Uranium

Under the bombardment of uranium by neutrons, recoil nuclei of great mass and high ionizing power are produced. According to the measurements of Frisch[1], the ionization which they produce along their tracks attains 70 Mev. Their range in air, measured by Joliot[2], is nearly 3 cm.

For these reasons, it was to be expected that the tracks of such recoil atoms would be observed on photographic plates with a thick coat of emulsion. Our first experiments[3] suggested this assumption. On a plate, 2 cm. × 3 cm., some thick and short tracks were obtained, which can be attributed to the uranium recoil nuclei. A preparation of radio-thorium plus beryllium being taken as a source of neutrons, besides the recoil tracks a considerable background of γ-rays was also observed on the plates.

In order to avoid the background in further experiments, irradiation was effected by the neutrons obtained from a cyclotron by means of the reaction D-D-*n*. The experiment itself was carried out in the following manner: a photographic plate was placed above a thick coat of metallic uranium powder at the distance of 2–3 mm. The plate was turned with the emulsion coat toward the uranium. The irradiation lasted 10 minutes. As a result, we obtained on the plate tracks of uranium α-particles and other tracks almost identical with them in range, but thicker and more continuous, which we believe to belong to the uranium recoil nuclei. The character of these tracks is shown on the accompanying figure, which shows a photograph of two tracks in the emulsion especially prepared for these experiments.

One of these tracks, continuous and thick, with a range corresponding to 1·6 cm. of air, belongs to a recoil nucleus. Another track, 2·5 cm. long, belongs to the α-particle of uranium. In the second track, separate grains can be discerned, and it can also be seen that this track is thinner. Although the composition of the emulsion was especially chosen in order to facilitate discrimination between recoil nuclei tracks and α-particle tracks, in many cases it is very difficult to do this, chiefly because many of the tracks are directed almost perpendicularly into the emulsion and therefore they cannot be examined in detail with the microscope. Moreover, the greater number of tracks come from the interior layers of the uranium and have therefore small ranges.



RECOIL NUCLEI. × 410.

If the counting is limited only to the tracks of range 1·5 cm. and more in air, then the plate of area 6 cm.² receives nearly six hundred recoil nuclei in a minute.

Although in our experiments the source of neutrons was nearly thirty times as powerful as that used by Frisch, our results agree fairly well with his data (15 particles in 1 minute from 300 mc.). Our data differ, however, greatly from the results of Roberts, Meyer and Hafstad[4] (30 particles in 1 minute from a source equivalent to 10 curies). It is possible that this contradiction may be explained by the fact that Roberts and co-workers counted only the impulses of energy 75–150 Mev.; however, according to our experiments, the action of the uranium recoil nuclei on the photographic plate is not expected to differ much from the action of α-particles. This would accord with the assumption of Joliot[5], who believes that the average energy of the recoil nuclei is only 25–35 Mev., and not 75–150 Mev. as Meyer and co-workers thought.

In conclusion, it is to be noted that after irradiation for three hours of bismuth, gold and platinum with neutrons from a cyclotron, no recoil nuclei were observed.

Radium Institute, Academy of Sciences U.S.S.R., Leningrad. March 19.

L. MYSSOWSKY.
A. JDANOFF.

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[2] Joliot, F., *C.R.*, 208, 341 (1939).
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Short-Range α-Particles from Oxygen, Nitrogen and Fluorine Bombarded with Protons

THE bombardment of fluorine by protons leads to the emission of a strong γ-radiation, for which the excitation curve shows well-defined resonances[1]. In a letter by Dee, Curran and Strothers[2], in which the nature of this γ-radiation is discussed, strong reasons are given for expecting the emission of a short-range α-particle group in the same transmutation, and it is pointed out that this group should show the same resonance excitation as is found for the γ-radiation. Assuming the γ-ray energy[3] to be 5·8 Mv., the calculated mean range of the α-particle group is 1·1 cm.

In some earlier work[4] on the transmutation of fluorine a search was made for this group, but no evidence of its presence could be obtained, although with a bombarding voltage of 450 kv. the measurements were extended to a range of 1 cm. Recent unpublished work in this laboratory on the energy of the γ-radiation has, however, shown that the figure of 5·8 Mv. is probably too low, and the calculated range of 1·1 cm. for the α-particles is thus too high. In order to investigate ranges of less than 1 cm., the bombarding voltage must be reduced to less than 450 kv. in order to prevent scattered protons from entering the ionization chamber.

Experiments at these low voltages have recently been carried out, and the emission of a group of α-particles of mean range 0·8 cm. from a thin barium fluoride target bombarded with 330 kv. protons has been established. (We understand that these short-range α-particles from fluorine bombarded with protons have also been discovered at Pasadena by McLean and Becker, using a cloud chamber.) A rough excitation curve for the production of these particles is given in Fig. 1 (curve *A*), and shows that they follow approximately the same resonance curve as that obtained for the γ-rays (curve *B*). The

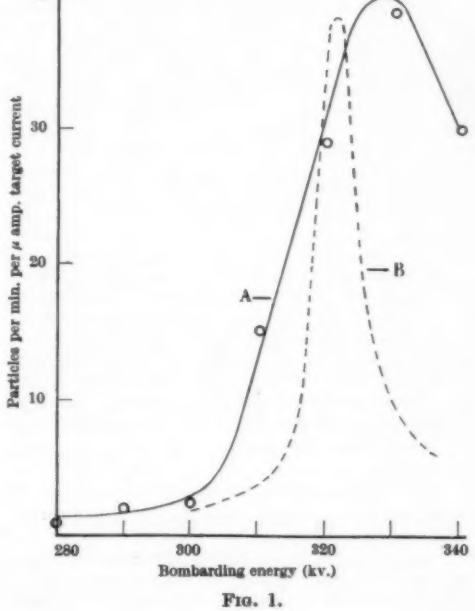

FIG. 1.

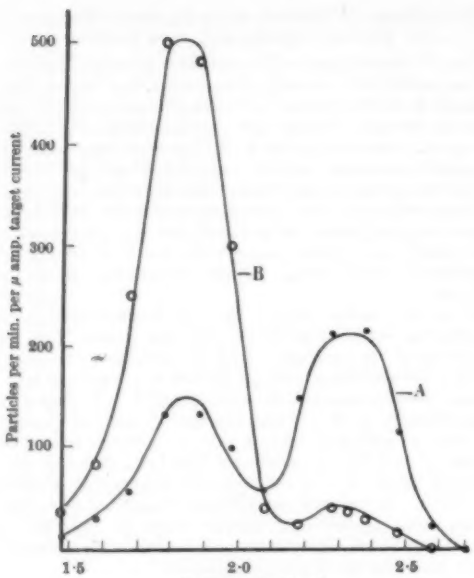

Fig. 2.

resonance character of the group makes its observation difficult, as it does not appear at bombarding energies below 300 kv. and is obscured by scattered protons above 400 kv. There is, however, a definite γ-ray resonance between these two voltages, and the occurrence of this peak in the α-particle excitation function indicates that these particles must be associated with the γ-radiation. A further discussion of the interpretation of the γ-ray process has already appeared[5].

In the course of this work, the emission of groups of α-particles of mean ranges $2{\cdot}07 \pm 0{\cdot}05$ cm. and $2{\cdot}57 \pm 0{\cdot}05$ cm. at 500 kv. bombarding energy was also observed from fluoride targets. These groups were also obtained from a carbon target, and it was suspected that they were due to nitrogen and oxygen contamination. Confirmation of this view was obtained by passing the proton beam from the accelerating tube through a thin aluminium window into a mixture of nitrogen and oxygen. The range distribution of the disintegration particles was investigated with a shallow ionization chamber. Curve *A* of Fig. 2 shows the α-particle groups obtained from air, and curve *B* those from a mixture of 20 per cent nitrogen and 80 per cent oxygen. The intensity ratio changes in the manner expected assuming the 2·07 cm. group to be due to the transmutation of oxygen and the 2·57 cm. group to that of nitrogen. These groups have therefore been interpreted as due to the disintegration of the rare isotopes of oxygen and nitrogen in accordance with the reactions

$$^{18}O + {}^{1}H \rightarrow {}^{15}N + {}^{4}He + Q_1, \quad . \quad . \quad . \quad . \quad (1)$$

and

$$^{15}N + {}^{1}H \rightarrow {}^{12}C + {}^{4}He + Q_2. \quad . \quad . \quad . \quad . \quad (2)$$

The observed energy releases are $Q_1 = 3{\cdot}96 \pm 0{\cdot}15$ Mv. and $Q_2 = 5{\cdot}00 \pm 0{\cdot}15$ Mv.

The mass of ^{15}N has been determined by Bainbridge and Jordan[6] from the mass-spectrograph doublet $^{14}N^{1}H$—^{15}N and is given as $15{\cdot}0050 \pm 0{\cdot}0003$, assuming that the mass of ^{14}N is $14{\cdot}0076 \pm 0{\cdot}0002$. This value of ^{15}N agrees with that obtained from disintegration data[4], and combining it with the observed value of Q_1, we obtain a value of $18{\cdot}0050 \pm 0{\cdot}0004$ for the mass of ^{18}O. The mass of this isotope has been given by Aston[7] as $18{\cdot}0057 \pm 0{\cdot}0002$ and by Mattauch[8] as $18{\cdot}00376 \pm 0{\cdot}0002$, and the present determination thus tends to support an intermediate value.

There is considerable discrepancy between the various values which have been obtained for the mass of ^{12}C; Aston gives $12{\cdot}00355 \pm 0{\cdot}00015$, Bainbridge gives $12{\cdot}00402 \pm 0{\cdot}00017$ and from disintegration data given by Cockcroft and Lewis[4] for the reactions:

$$^{16}O + {}^{2}H \rightarrow {}^{14}N + {}^{4}He, \quad . \quad . \quad . \quad . \quad . \quad (3)$$
$$^{14}N + {}^{2}H \rightarrow {}^{12}C + {}^{4}He, \quad . \quad . \quad . \quad . \quad . \quad (4)$$

a value of 12·0043 is obtained using Aston's value for the masses of ^{4}He and ^{2}H. From the observed Q_3 we calculate that the mass of ^{12}C is $12{\cdot}0038 \pm 0{\cdot}0004$, assuming Bainbridge's mass of ^{15}N. Our value for the mass of ^{12}C is thus based ultimately on Bainbridge's mass of ^{14}N, which is in agreement with the value obtained from reaction (3). The energy release found by Cockcroft and Lewis for reaction (4) enables the mass of ^{12}C to be calculated directly from that of ^{14}N, and this gives a value of 12·0040, in good agreement with our value.

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April 22.

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The Meson and its Transformation into Heavy Particles

The meson or mesotron was first introduced by Yukawa to serve as the connecting link between β-ray disintegration and the forces responsible for nuclear binding. Subsequent work has identified it with the penetrating component of the cosmic rays, but the meson has not so far been observed in nuclear reactions (apart from cosmic rays), for the necessary energy of about 100 Mev. has not been available except in the recent experiments on the fission of the uranium nucleus, which, however, have not so far been investigated in sufficient detail to make any definite conclusion possible.

Following Yukawa, the meson is assumed to obey the Bose statistics. This is necessary if the neutron-proton interaction is brought about through the meson only; but if the existence of neutral particles, called neutrettos[1], be also postulated, then the proton-neutron interaction will be brought about through the exchange of a meson and a neutretto, and will lead to two alternatives for the statistics obeyed by the intermediate particles: (1) both the meson and the neutretto obey Bose statistics; or (2) both obey Fermi statistics. Case (1) corresponds to that studied in detail by Bhabha, Heitler, Kemmer and others, but possibility (2) has not been fully explored, and, therefore, the statement that the meson obeys Bose

statistics can at the present stage be regarded only as an assumption.

The spontaneous transformation of a meson into an ordinary electron and neutrino has been discussed theoretically[2], and the 'decay period' has been found to be in reasonable accord with observations on the mass absorption anomaly for cosmic rays. We have considered the possibility of a meson being transformed into two heavy particles, a proton and a neutron. The initial energy of the meson must of course exceed about $2Mc^2 \sim 2 \times 10^9$ ev., M being the proton mass, to provide the proton and neutron rest-mass energies. The transformation probability is proportional to g^2, where g is the usual constant (dimension, electric charge) characterizing the strength of the nuclear field surrounding a neutron or a proton. This probability comes out to be very high, and it seems that the protons and neutrons found in cosmic rays are possibly due to the spontaneous transformation of mesons of very high energies

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PHYSICS AND CHEMISTRY

Preliminary Report on the Masses of ^{13}C and ^{14}N

WITH a newly constructed mass-spectrograph of Bainbridge and Jordan type[1], we measured the mass differences of $^{13}CH_4 - ^{16}O$ and of $^{13}CH_2 - ^{14}N$. These ions were produced by electric discharge through a mixture of methane, carbon dioxide and air in a cylindrical discharge tube of the usual type. In addition to these doublets, lines of NH_2, NH_3, CH_2, CH, C were also simultaneously obtained on the same plate. Photographic plates employed in this work were prepared from the commercial process plates by Schumannization, 10–20 seconds being sufficient for photographing spectral lines on these plates.

By measuring every interval of these lines with $^1H = 1{\cdot}008$, a dispersion coefficient at every point on the plate was determined empirically as accurately as we wanted.

Since difference in dispersion coefficient at various parts of the plate was found to be very slight, and moreover no systematic error took place during the measurement, the determination of dispersion coefficient with our method can be quite justified, and the following results were obtained:

Doublet	Number of doublets measured	Difference of mass
$^{13}CH_4 - ^{16}O$	16	0·03642 ± 0·00009
$^{13}CH_2 - ^{14}N$	38	0·01257 ± 0·00006

From these results and Aston's $^1H = 1{\cdot}00812 \pm 0{\cdot}00004$ [2], isotopic masses of ^{13}C and ^{14}N can be calculated as follows:

$$^{13}C = 12{\cdot}00394 \pm 0{\cdot}00018.$$
$$^{14}N = 14{\cdot}00761 \pm 0{\cdot}00021.$$

A full account will be published elsewhere.

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Discrepancies in the Isotopic Weight of ^{12}C

OF some forty isotopic weights so far determined by the doublet method, more than half depend on that of ^{12}C as a substandard. As chairman of the International Committee on Atoms, I am anxious that some agreement should be reached on this isotopic weight to enable a satisfactory table to be adopted. Ill-health has prevented me making any further measurements for the past year, but Mattauch has recently published results[1] indicating that my value 12·00355 ± 0·00015 is too low. He gives as his own 12·003876 ± 0·000032, closely agreeing with Bainbridge and Jordan's latest value, 12·00398 ± 0·00009. Much as I regret being compelled to criticize the results of other workers, I feel it may be well to explain some of the reasons which prevent me accepting the high value with entire confidence.

My first criticism concerns the accuracy claimed. My own figure corresponds to an uncertainty of position of a line on the photographic plate of 0·0075 mm., Bainbridge's to 0·0045 mm.; Mattauch's, owing to the much smaller dispersion of his apparatus, to 0·0003 mm., which seems very small for photometric measurements. My second and more important criticism is the possibility of some systematic error in the instruments. The fundamental discrepancy in the doublet O—CH_4 could be explained by supposing that my apparatus gives the mass of the molecule too low relative to that of the atom, or that the other types give it too high. What evidence is there for either of these possibilities? Suspicious of the first, I checked the mass of ^{12}C by as many different methods as possible[2]. One, the doublet CO—C_2H_4, only used molecules and others only used atoms; all gave results consistent with my low value, which was further supported by more measurements of the doublet ^{40}A—C_2H_4 [3] and by work on ^{49}Ti [4].

The three doublets CO—$^{14}N_2$, C—$^{10}BH_3$ and ^{20}Ne—CD_4 quoted by Mattauch to check his high value are neutral in their evidence, for it so happens that if my values for all the atoms concerned are put in, the agreements are equally good.

To use a loose optical analogy, Mattauch and Bainbridge's double focusing is related to my single focusing as a lens to a pin-hole. The lens gives greater sharpness, higher resolution and in most cases higher accuracy, but it may on the other hand

produce distortion not likely with a pin-hole. In connexion with such possible distortion, several points may be noted. The first is the asymmetry of the lines in the O—CH_4 doublet which caused Bainbridge to reduce his first estimate of $0{\cdot}0369 \pm 0{\cdot}0002$ for the difference in mass[5] to $0{\cdot}03649 \pm 0{\cdot}00008$[6], which was very nearly halfway to mine, $0{\cdot}03601 \pm 0{\cdot}00016$. Then Mattauch[7] states that in his measurements of the N—CH_2 doublet his plates were unaccountably inconsistent, some agreeing better with my value of this doublet than with Bainbridge's.

Two other cases are of interest. Mattauch[8] measured the doublet ^{18}O—$^{16}OH_2$ obtaining a value for the mass of ^{18}O of $18{\cdot}0037 \pm 0{\cdot}0007$. My own measurements[3] of this doublet indicate a higher value, $18{\cdot}0057 \pm 0{\cdot}0002$, in much better agreement with the best optical determination of Babcock and Birge[9] of $18{\cdot}0065 \pm 0{\cdot}00018$.

In 1937 Mattauch, in collaboration with Hahn, demonstrated the formation of ^{87}Sr in rubidium material. In connexion with this piece of work, which I consider one of the most beautiful ever made in the application of mass-spectra to chemical problems, he measured[10] the doublet ^{86}Sr—$^{28}SiF_2$ and found a difference of packing fraction of $9{\cdot}0 \pm 0{\cdot}5$. It is now known that the packing fraction of the comparison molecule is very exactly zero, but from Dempster's packing fraction curve[11] and the measured value for the isobare $^{86}Kr^2$, which is $-7{\cdot}40$, or $-7{\cdot}13$ if we use the high value of ^{12}C, it seems reasonably certain that so large a negative value as $-9{\cdot}0$ is inadmissible. It will be noted that both these discrepancies are of the same sign and suggest the same explanation.

Considerations such as these make me doubt the wisdom of adopting a value depending on measurements of one doublet only. I checked my value with the doublets CO—C_2H_4, ^{40}A—C_3H_4, ^{36}A—C_2 and $^{36}A^{++}$—OH_2. Measurements of these with a double focus mass-spectrograph would be of great help in the present uncertainty. In the meanwhile, it is a matter of some satisfaction that the whole difference remaining amounts to 27 parts in a million—only twice my estimated error.

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April 29.

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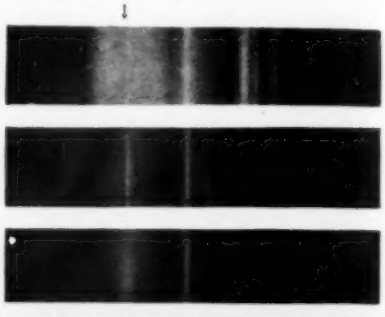
Rigidity of Liquids

As was reported by us in a recent note[1], the monochromatic radiations of the zinc arc, namely, 4680, 4722, 4810 A., diffused longitudinally by liquid glycerine at 26° C., revealed, on either side of the primary lines, the presence of sharply defined displaced components in the spectrum of the scattered light. The spectral shifts of these components is $0{\cdot}52$ cm.$^{-1}$, corresponding to a modulation frequency of $1{\cdot}53 \times 10^{10}$ sec.$^{-1}$.

On the basis of the usual Brillouin formula, the velocity of the acoustic waves giving rise to these components comes out as 2500 metres per sec. This is considerably higher than the ultrasonic velocity of 1910 metres per sec. as determined for glycerine at the same temperature for longitudinal waves of frequency 10^7 sec.$^{-1}$, generated by the piezo-electric method. That sound waves of such high frequencies as $1{\cdot}53 \times 10^{10}$ should be observable at all in a liquid so highly viscous as glycerine is unintelligible on the classical hydrodynamics. It appears to us that Clerk Maxwell's concept[2] of fluid viscosity as a fugitive elasticity resolves this difficulty and, in addition, offers a ready explanation for the observed great difference between the velocities for 'hypersonic' and 'supersonic' waves.



Spectra of 4046 A. mercury radiations scattered by liquids.

It is clear that if a liquid possesses rigidity, the velocity of propagation of the longitudinal waves of sufficiently high frequencies would be $\sqrt{\frac{k + 4/3\, n}{\rho}}$ instead of $\sqrt{\frac{k}{\rho}}$, k and n being the bulk modulus and rigidity modulus respectively of the liquid. Taking these two expressions as giving the velocities of sound in the hypersonic and ultrasonic ranges of frequencies respectively, the bulk modulus comes out as $4{\cdot}6 \times 10^{10}$ and the rigidity modulus as $2{\cdot}4 \times 10^{10}$, the former agreeing closely with the reciprocal of the directly observed adiabatic compressibility.

The foregoing explanation of our results finds strong support from the fact that the time of relaxation calculated from the viscosity and the rigidity of glycerine, by using the Maxwell formula $\eta = nT$, comes out as $3{\cdot}5 \times 10^{-10}$ sec., which is much larger than the actual value of the time period, $0{\cdot}65 \times 10^{-10}$ sec., of the observed Debye waves. Further, we have found that with rising temperature, the divergence between 'hypersonic' and 'ultrasonic' velocities in glycerine diminishes, as is to be expected from the rapidly falling viscosity and the consequent diminution of the relaxation time.

Our observations thus seem to establish, experimentally, the thesis that for mechanical disturbances of sufficiently high frequencies, a liquid behaves essentially as a solid. On the basis of this thesis, it becomes easier to understand the general relation

between light-scattering and fluid viscosity, illustrated in the accompanying spectra of light scattered in four liquids of increasing viscosity, namely, benzene, acetic acid, salol, and glycerine, all of which depolarize light strongly. It will be noticed that in the spectrum of glycerine the rotational 'wings' accompanying the Rayleigh line, which are so prominent a feature with the more mobile liquids, are almost completely absent, thus indicating that, in respect of light-scattering, glycerine is practically indistinguishable from an amorphous solid.

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April 1.

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Anomalous Properties of some Anhydrous Salts of the Iron Group at Low Temperatures

IT has been established in the Leyden Laboratory[1] that the susceptibility of nickel, cobalt, ferrous and chromium chlorides at the temperatures of liquid hydrogen depends on the intensity of the magnetic field.

It has been found in our laboratory[2] that all these substances show jumps in the specific heat similar in shape to those exhibited by ferromagnetics. These two facts have led to the view that the anomalies observed, namely, dependence of the susceptibility on the field and the jumps of the specific heat, might be due to a transition of the salts from the paramagnetic to the ferromagnetic state. A detailed investigation of the temperature dependence of the susceptibility, carried out by us, showed that the ferrous and cobalt chlorides and cobalt iodide exhibit at the temperature of the specific heat jump a maximum of susceptibility the position and sharpness of which depends on the intensity of the magnetic field, and in such a manner that on increasing the field the maximum shifts to the lower temperatures. This fact does not fit in with the usual notions of ferromagnetism. The low value of the susceptibility and the absence of signs of saturation in these salts are likewise inconsistent with the hypothesis of ferromagnetism.

It seems possible to explain the dependence of the susceptibility on the field, the anomaly of the specific heat and the temperature dependence of the susceptibility by the 'quenching' of the orbits of metallic ions in the electric field of the crystal, a concept introduced by Stoner. The dependence of the susceptibility on the field is then accounted for by the external magnetic field forcing out the orbits from their quenched states, that is, increasing the effective number of the carriers of magnetism. The temperature influences the quenched orbits in the same sense, namely, increase of the temperature diminishes the effectiveness of the crystalline field. The existence of the maximum of susceptibility is accounted for by the increase of the effectiveness of the electric field due to the lowering of the temperature, and its location is determined by the internal electric field, the temperature and the external magnetic field. As the latter two are disturbing factors with regard to the quenching of the orbits in the crystalline field, the increase of one of them, say, of the magnetic field, diminishes the temperature of the maximum. The jump in the specific heat is due to the orientation of the orbital moments in the crystalline field.

Investigations of the magneto-caloric effect and the specific heat of ferrous and cobalt chlorides in magnetic field, carried out by G. Miljutin and S. Shalyt, show that at temperatures below that of the susceptibility maximum the magneto-caloric effect is negative, that is, the salt cools when the magnetic field is applied and vice versa. The position and magnitude of the specific heat jump depend on the intensity of the magnetic field. These new facts support the hypothesis of the quenching of the orbits and cannot be explained by the ordinary transition to the ferromagnetic state.

A detailed description of the results obtained will appear in the *Journal of Experimental and Theoretical Physics* (Russian).

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March 21.

[1] *Leid. Comm.*, 29 *b*; 173 *b*; 173 *c*; 201 *a*.
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Experiments on Pumping Liquid Helium to Low Temperatures

TEMPERATURES sensibly lower than those usually attained by pumping liquid helium are accessible now that the design of apparatus can take into account the known characteristics of the creeping film phenomenon[1] of liquid helium II. In a previous paper[2] it was shown that temperatures below 0·8° K. could be reached very simply by constricting the lower part of the pumping tube, to restrict the creeping of the helium II film. We suggested that still lower temperatures might be attained by using a membrane pierced by a small hole instead of the constriction tube. The advantage of this design is that it reduces the film flow while offering the minimum impedance to the flow of gas evaporating from the surface of the liquid owing to the normal heat influx.

Experiments in which the hole was 0·15 mm. in diameter have confirmed this suggestion: using an ordinary laboratory pump of speed 10 litres/sec., we obtained a temperature of 0·73° K. in a vessel of 4 c.c. capacity. The temperature was measured magnetically using chrome alum as thermometer, and calibrating its magnetization (corrected to that of a sphere[3]) against temperature between 4° K. and 1·5° K., as given by Keesom's 1932 vapour pressure curve[4].

There is at present an uncertainty of some hundredths of a degree in the value of the temperature reached. If Keesom's 1937 vapour pressures[4] are used in the calibration, the figure for the temperature becomes 0·76° K. Some of the values on the 1937 curve are probably in error, however, for application of the Clausius-Clapeyron equation leads to improbable thermal properties of helium gas. Also, careful measurements of vapour pressure against the susceptibility of paramagnetic salts (which form a more adequate thermometer in this region than can a gas thermometer) indicate that there is some inconsistency in both vapour pressure curves. (This question is being further investigated in the Clarendon Laboratory.) The same uncertainty, of course, applies

also to previous experiments[6] on the lowest temperatures attained by pumping liquid helium (0·71° on the 1932 scale), so we can state that the region of temperature hitherto available only with the elaborate apparatus of these earlier experiments is now accessible with the simple means described.

As the pierced membrane used in the above experiment offers an appreciable resistance to gas flow, we are now engaged on experiments to determine the size of membrane hole best suited to different conditions of heat influx to the apparatus. For this purpose the normal heating (that is, by gas conduction and radiation) to vessels less well insulated is simulated by enclosing an electrical heating coil in the helium vessel. These experiments have shown that a hole of 0·15 mm. diameter is too small unless the heat influx can be reduced below 1 millical./min. For example, a heat influx of 3·5 millical./min., which is roughly that occurring in our ordinary 30 c.c. vessel for demagnetization experiments, gives a temperature of 1·05° K. with a 0·15 mm. hole, while with a bigger hole it is again possible to reach below 0·8° K.

A complete account of these experiments will be given later.

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Polymorphism of the Micas and Diffuse X-Ray Scattering of Layer Silicate Lattices

The first significant work on the structures of the micas was that of Maugin[1], who measured the units of structure and discussed types of isomorphous replacements. Pauling[2], on the basis of his co-ordination theory, proposed general structures that were shown by Jackson and West[3] to be correct in some detail for muscovite. Maugin noted that the lattice dimension along the *c* axis of a biotite crystal was apparently one half that of muscovite, and he further observed diffuse scattering of X-rays from several crystal zones.

Muscovite contains close-knit layers approximating $[[(Al_2)AlSi_3O_{10}(OH)_2]]^n$ in composition that are joined across the cleavage plane by potassium atoms having twelve-fold co-ordination. The unit of structure chosen by Jackson and West is crossed by two such layers related by a glide reflection plane, the crystal symmetry being monoclinic holohedral. Phlogopite results from replacing (Al_2) with octahedral co-ordination by (Mg_3), which completely fills the octahedral positions; in biotite, (Al_2) is replaced by magnesium and iron.

Examination of many micas now brings to light a great variety of structure. Biotite, phlogopite, lepidomelane, zinnwaldite and lepidolite often have a single layer structure, the crystal symmetry being monoclinic hemihedral. A pseudohexagonal three-layer structure is also frequently found for lepidolites and zinnwaldites. Two-layer structures, similar to but not identical with that of muscovite, have been found for four of the fifty biotite-like samples examined. Several biotite samples were found in which the unit of structure apparently was crossed by six, eight and ten layers. In the last case, the lattice periodicity is more than 100 A. in a direction normal to the unique monoclinic axis, which introduces some question about the extent of an element in the crystal mosaic. Twenty samples of muscovite, including seven specimens associated with biotite or lepidolite (zoned crystals), all had a two-layer structure, and none showed diffuse reflections.

Many of the biotite-like samples give diffuse scattering of X-rays in $[h_a k_a l]$ zones for which the k index is not a multiple of three. This is a result of random combinations of the various structures. Thus if some elements of the three-layer arrangement are replaced by a two-layer structure, the periodicity along the *c* axis will be destroyed for those planes with the k index other than a multiple of three, and reflections from such planes will be broadened. Random elements in the single-layer structure give rise to diffuse scattering but do not prevent close agreement between observed and calculated intensities. In structures of higher layer multiplicity, a few random elements make intensity calculations impossible by introducing an indeterminate phase shift, but do not necessarily lead to diffuse scattering as is shown by the layer minerals dickite, talc and pyrophyllite as well as by the micas.

The uniqueness of the muscovite structure is a result of its departure from the ideal arrangement proposed by Jackson and West. This departure, which is considerable, is shown by the relatively high intensities of reflections from (06*l*) with l odd, which should be absent for the ideal structure as they are for the biotites. Incomplete filling of the octahedral co-ordination positions in muscovite leads to distortion of the co-ordination and therefore of the layer. As a result, there is but one way in which the twelve-fold co-ordination of potassium between layers can be obtained. In the biotites, complete filling of the octahedral positions gives a regular arrangement within a layer and thus permits various combinations of layers. Even the two-layer biotite structures have (06*l*), l odd, reflections absent.

The distinction between muscovites and biotites, from mineralogical data, has partially been recognized by Winchell[4]. Diffuse scattering of X-rays from the micas has features in common with the phenomena described by Preston[5] and Guinier[6] for alloys. Considerable time will elapse before detailed analyses of the many structures observed can be published.

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Interrelation of Dissociation Energy, Internuclear Distance and Bond Order for Carbon-Carbon Linkages

Fox and Martin[1] have found that the heat of dissociation (D kgm.-cal.) for different carbon-carbon linkages (organic compounds, graphite, diamond) follows smooth curves when plotted against either internuclear distance (r_e angstroms) or bond order x. When the assigned values of any pair of the three magnitudes D, r_e, x are plotted against each other

logarithmically, approximately linear relations are obtained, from the slopes and intercepts on the axes of which it may be deduced that the following relations should hold very approximately:

$$Dr_e^3 = 282 \quad (1)$$

$$x^{2/3}r_e^2 = 3{\cdot}7 \quad (2)$$

Fox and Martin[2] have independently deduced the relation Dr_e^3 equals a constant, by a semi-empirical method, as consistent with a potential energy function of a simple form recently proposed by Sutherland, and with a modified Morse-Clark relation connecting bond constant k_e with r_e. It is of interest to note that the latter type of relation, originally devised for spectroscopic diatoms only, is found to have application to molecular linkages. This has also been shown by Thompson and Linnett[3].

In the last two columns of the table below, r_e is calculated from D and x from r_e (calc.), using (1) and (2).

C—C link	D	r_e	x	Dr_e^3	$x^{2/3}r_e^2$	r_e (calc.)	x (calc.)
Acetylene	161	1·204	3	281	3·63	1·205	3·07
Band spectrum	126·8*	1·308	2	284	3·55	1·305	2·15
Ethylene	125·1	1·33	2	294	3·74	1·31	2·10
Benzene	105·3	1·40	1·62	289	3·78	1·39	1·62
Graphite	100	1·42	1·45	286	3·67	1·41	1·50
Diamond	75	1·54	1	274	3·65	1·55	0·98
Hydrocarbons	71·8	1·56	1	270	3·76	1·58	0·91

* Approximate assignment for C_2 by Mulliken[4] (5·5 volts).

It should be mentioned that the data involve the uncertain heat of sublimation of carbon (S kgm.-cal.). The D values above depend partly upon the estimate of Sidgwick and Bowen[5], $S = 150$. If we follow Fox and Martin and take the true value to be $S = 150 + q$, where q is unknown, it is found that the slope and degree of linearity of the logarithmic D/r_e lines are little affected by changes in q over a wide range from $q = -20$ to $+100$. The best exponents for r_e in (1) range from about 2·9 to 3·4 as q changes from -20 to $+40$, with corresponding changes in the constant term of (1). If we adopt Herzberg's[6] value $S = 124$, the r_e exponent in (1) is 2·8, so that the form of the relation is practically unaffected. The value $S = 140$ makes Dr_e^3 as nearly constant as possible, and the constant in (1) takes the general form $282 + 2{\cdot}13\,q$. The relation (2) is independent of S.

Fox and Martin have obtained good additive relations for the heats of formation of various organic compounds on the basis of their assignments to individual linkages on the assumption that the C—C (and C—H) single bond energies are constant. The accurate work of Rossini[7], however, indicates that even in paraffin hydrocarbons, C_nH_{2n+2}, these linkages differ slightly in D values, and that only for n greater than 5 is the increment in D for each CH_2 added constant. It is hoped that the present work may assist in the task of assignment of individual linkage contributions more accurately than is at present possible.

C. H. Douglas Clark.
Department of Inorganic Chemistry,
University, Leeds.
March 27.

[1] Fox, J. J., and Martin, E. A., *J. Chem. Soc.*, 2106 (1938).
[2] Privately communicated.
[3] Thompson, H. W., and Linnett, J. W., *J. Chem. Soc.*, 1384 *et seq.* (1937).
[4] Mulliken, R. S., *Rev. Mod. Phys.*, **4**, 1 (1932).
[5] Sidgwick, N. V., and Bowen, E. J., *Ann. Rep. Chem. Soc.*, 367 (1931).
[6] Herzberg, G., *Chem. Rev.*, **20**, 145 (1937).
[7] Rossini, F. D., *Bureau Stand. J. Res.*, **13**, 21 (1934).

Demonstration of Optical Interference Figures

It is not generally known that by using 'Polaroid' filters of sufficient size (1¼ in. to 2 in. diameter), optical interference-figures afforded by crystals in convergent polarized light—most difficult subjects to project satisfactorily on a screen—are obtained in a simplified manner with results exceeding in clearness and brilliance those got by the older apparatus.

As shown in Fig. 1, the left-hand side consists of the usual source of light, L, either arc or coiled-filament lamp, W, a water-cell, Ab, an ordinary Abbe condenser and S, the stage. P is the polarizer,

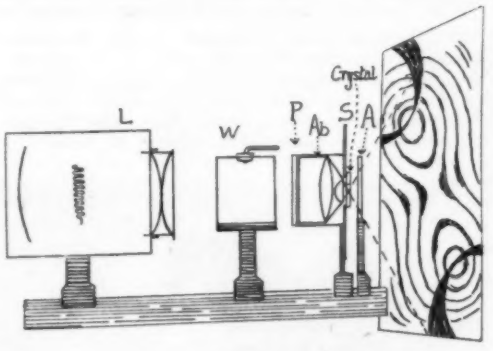

Fig. 1.

Sketch of projection apparatus using 'Polaroids'. Note simplification of the R.H.S.

large enough to give full scope to the width of the Abbe. This is standard practice, except that a 'Polaroid' filter may be used for P. The departure from the usual practice is in having no lenses whatever between crystal and screen, in fact, nothing but the largest available 'Polaroid', A. A large, even interference figure results, and if A is placed close to the specimen, the full aperture of the Abbe is made use of. Actually, the optic axes of Rochelle salt can just be brought in ($2E = 120°$). For intermediate optic axial angles, for example, mica, sanidin, borax, etc., the results are excellent. With uniaxial figures, up to 36 rings have been counted, under optimum conditions. Figs. 2 and 3 are from actual photographs of the *screen itself* with the figure projected on it. The screen should not be more than a foot from the

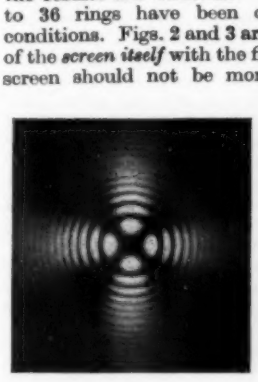

Fig. 2.

Photograph of screen with uniaxial figure from KH_2PO_4 projected on it.

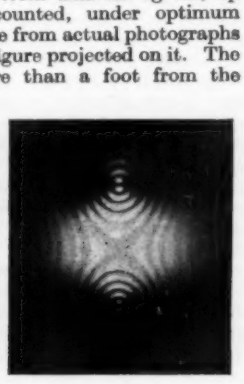

Fig. 3.

Photograph of screen with biaxial figure from mica cleavage.

analyser for large $2E$ values, but may be any distance for uniaxial crystals. A translucent screen, with the class on the far side, is better for a 'front' view.

The apparatus used by me was a microprojector, supplied by Flatters and Garnett of Manchester, a 3-ft. circle being well illuminated with a 48-watt, low-voltage lamp. Cheaper grades of 'Polaroid' are also effective.

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Measurement of the Amount of Steam Escaping from Areas of Volcanic or Solfataric Activity

On the slopes of Mt. Tongariro in the Tongariro National Park, New Zealand, there is a remarkable area of solfataric activity called Ketetahi Hot Springs. One of the most noteworthy features is the column of steam arising from the vigorous fumaroles of this area. This column of steam has been noted by Hochstetter[1], who gave a drawing of the volcanic peaks from Ongarue, 36 miles away, and in this the column was clearly shown. Thomas[2] stated that it was visible for fifty miles, and although it has not been possible to check this, the statement is probably still correct in favourable circumstances.

In March 1935, I attempted, among other physical and chemical investigations at this area, to estimate the amount of steam escaping. The method was based on the fact that the actual amount of water in the droplets forming a cloud is small in comparison with the water present as vapour in saturated air. The droplets, however, define the extent of the air saturated with water vapour from the fumaroles. If the original humidity be known, and the cross-sectional area and velocity of the cloud be observed, it should be possible to calculate the output of the fumaroles. The water present as droplets is of importance only if the original humidity be high. In observations by Köhler[3] on ordinary clouds, the amount ranged from 0·12 gm. to 0·96 gm. per cubic metre. As a mean, an addition of 0·5 gm. was made to allow for the visible droplets.

Observations were made at humidities from 60 to 96 per cent, determined by wet- and dry-bulb thermometers in an improvised screen. The size of the cloud, and the velocity of ascent in calm weather, or of sidewards dispersion by wind, were determined in various ways. From the Ketetahi hut, about ¾ mile distant, the steam appears as two columns, which at about 80 per cent humidity are 100 metres and 50 metres in diameter respectively. The roughest measurement was that of the size of the cloud. It had to be assumed that the cloud was circular in cross-section. For vertical ascent the diameter was estimated, and in a strong wind the diameter of the horizontal cloud could be determined with the aid of an inclinometer. The velocity in calm weather could be found from the observation from the hut of the time for the cloud to rise to the height of the summit of Te Mari, and in a wind, from the time to blow over the face of Tongariro. Measurements were also made at the active area with an anemometer. Here, on the driest day, the size of the clouds from the individual fumaroles was estimated on the field and from a photograph. A final assumption was that the temperature in the cloud was the same as in the surrounding air. This should be approximately correct at a sufficient distance from the fumarole. In calm weather, the rise of the column is assumed to be due to the lower density of saturated air, and not to a difference of temperature. The results of various estimates ranged from 30 lb. to 120 lb. of steam per second. The best value was taken as 50 lb. per second or 180,000 lb. per hour, which is about the yield of a small steam well in Tuscany or California. For comparison, it may be mentioned that the steam required to heat the water in the hot stream flowing from the area was only 0·6 lb. per sec.

[Photo by Dr. P. Marshall

Crater of White Island.

In November 1938, Dr. P. Marshall made arrangements for a visit to White Island, the active volcano in the Bay of Plenty, and invited me to assist him on the chemical side. To reach White Island, a launch trip of fifty miles on the open sea is necessary, and the bad landing made possible a stay of only 1½ days. In this short time, with much other work to be done, only very rough observations could be made. Four main columns of steam, 120, 60, 30 and 20 metres in diameter were observed. From the humidity and the time to rise to the level of the crater rim, the output was estimated as 1,000 lb. per second. This would make the area twenty times as active as Ketetahi, a not unreasonable estimate.

In view of the great importance of water vapour in all volcanic phenomena, it was thought desirable to direct attention to this method of estimating the activity of solfataric and volcanic areas. With suitable instrumental aid, and more time for thorough observations than was available, the method might be used for comparing the activities at different localities and recording changes in the activity of areas under observation at intervals.

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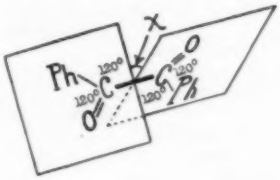
[1] Hochstetter, "Reise der O. F. Novara", Geol. Teil, 1 (Wien, 1864).
[2] Thomas, *Trans. N.Z. Inst.*, **20**, 306 (1888).
[3] Köhler, *Geofysiske Publikasjoner*, **5**, 1 (1930).

Benzil—a Skew Molecule?

THE values of the dipole moments of benzil and phenanthraquinone in various solvents, determined by us, and summarized below, suggest that the former molecule has a skew configuration in which the two $C_6H_5-\overset{|}{C}=O$ units lie in planes which are nearly mutually perpendicular (see figure).



Solvent	Benzil	Phenanthraquinone
n-Hexane	3·4$_5$ D.	—
Dioxan	3·7$_5$ D.	5·6$_5$ D.
Carbon tetrachloride	3·6$_5$ D.	—
Benzene	3·7$_5$ D.	5·5$_5$ D.
Carbon disulphide	3·4$_4$ D.	5·5$_5$ D.

This is seen if a certain structural similarity between benzil and phenanthraquinone be assumed, because then the moment of the latter can be taken as that of the completely *cis* form of the former, whence the component moments acting in the directions of the $>C=O$ links are each of $3\cdot2_3$ D. magnitude. Knowing this, the effective degree of departure of benzil from a co-planar model can be calculated, since, from symmetry, during rotation of the two benzoyl groups, only those resolutes acting at right angles to the axis of rotation will contribute to the experimentally measured resultant; therefore—if the two rotatable halves of the molecule are set in planes making an angle $\chi°$ with one another—this resultant is given approximately by $R = 3\cdot2_3 \cos 30 \sqrt{2(1 + \cos \chi)}$, from which values of χ between 90° and 100° are obtained by substitution of the results in the accompanying table.

If this conclusion is correct, benzil is the third molecule for which a 'skew' configuration seems to be necessary, the previous two[1] being hydrogen peroxide and hydrazine. We think that the reasons advanced by Penney and Sutherland[1] for the last cases, however, cannot apply to benzil, which is probably a molecule the shape of which is set by the superposition of electrostatic and steric repulsive forces (tending to produce a *trans*-structure) and van der Waals' attractions (tending to produce a *cis*-structure). In connexion with this point, it is relevant to note that published data[2] show that diacetyl, for which the van der Waals' attractions must be weaker than for benzil, has a definitely greater χ angle (130°–140°).

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April 1.

[1] Penney and Sutherland, *Trans. Faraday Soc.*, **30**, 898 (1934).
[2] Zahn, *Phys. Rev.*, **40**, 291 (1932).

The Vector Map of the Cyclol C_2 Molecule

THE vector map of a projection of the cyclol structure C_2 prepared by D. P. Riley and I. Fankuchen[1] provides elaborate illustrations of the rudiments of map theory. Particularly is it to be noticed that the weaker of the two peaks in the map is not the projection of a peak which could be observed in an equally coarse vector map of the skeleton in three dimensions. In this respect, the diagram illustrates a distinction between dominant features of a crude map and precise details of a complete map: in a complete map of a projection, every point against which there is an entry is necessarily the projection of some point in space against which there is an entry in the complete three-dimensional map.

If vector maps are to be utilized in science, care must be taken that the assurance proper to the realization that the nature of the relation between a point structure and its vector map is a problem in pure mathematics is not transferred to assertions which have no mathematical basis. When Riley and Fankuchen say that their projection "could reasonably be expected to bear some resemblance to that due to the whole molecule", I can only point out, by way of warning, that if the four triangular faces of the C_2 skeleton were omitted, much more than one third of the skeleton would remain, but the peaks of Riley and Fankuchen's own map would no longer emerge.

Again, there are no mathematical grounds for the statement by Riley and Fankuchen that side-chains roughly perpendicular to the plane of projection "cannot alter the fundamental pattern of the vector map". Even a few side-chains perpendicular to the plane can easily alter the intensity of every entry and therewith alter the shape of every contour and destroy or create recognizable peaks.

I am not, of course, presuming to suggest that Riley and Fankuchen's expectations may not be justifiable somehow for the particular case with which they are dealing, or to deny that when the structure of insulin is known the effect of the side-chains in the vector map may turn out to be as slight as the writers affirm. I am concerned only to protest, in view of the setting in which they have been displayed, that neither expectation nor affirmation can claim the support of general mathematical theory.

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April 15.

[1] NATURE, **143**, 648 (1939).

Biology

Effects of Veiling Glare in Binocular Vision

T. Murray Martin and R. W. Pickford have reported an experiment on the effects of veiling glare on size perception in monocular vision[1,2]. A differential veiling glare is often present in fog vision, when one object is seen through more fog than another. The present experiment, which was on binocular vision, dealt with size and distance perception when two similar objects were seen through a veiling glare greater over one object than over the other.

A box blackened inside was divided into two sections by a milk glass panel. Eyeholes in one wall and an opening opposite gave the subject an unbroken field of vision about one metre by two, at three metres distance. In the right-hand section were two 60-watt lamps. Light from either of these, passing the milk glass, produced a veiling glare in the subject's eyes, by reflection from a piece of plate glass set across the left-hand section at 45° to the line of vision. The lamps were set apart so that either produced a glare about twice as intense at one side of the visual field as at the other. The subject saw two white disks 11 cm. in diameter standing about 60 cm. apart on a blackened table, against a black background, lit by a 40-watt lamp above his head. He could vary the distance and apparent size of the disks by pulling strings. They varied slightly in relative height but not in apparent distance apart. Either disk could be used as a standard at 300-cm. distance. The greater glare could be on the right or left. The variable disk could be set initially too far away or too near. The eight possible combinations of conditions were used in turn and an equal number of readings taken for each.

Subjects 1 and 2 were instructed to move the variable until it seemed at the same distance as the standard. They often made a rather wide adjustment, were then dissatisfied and made a narrower adjustment. They said the wide difference represented apparent equality of distance, but left apparent inequality of size. If these attitudes to size and distance alternated unconsciously in fog vision in everyday life it might give rise to serious accidents. The remaining subjects were tested twice, first for distance and then for size perception. All agreed that equality for apparent distance left inequality of apparent size and vice versa.

Subject	Method	Mean reading cm.	Number	S.E. cm.	p.
3 m.	Distance	− 4·1	80	1·20	< 0·01
6 f.	,,	+ 7·5	40	1·86	< 0·01
9 f.	,,	+ 4·1	40	1·04	< 0·01
5 m.	Size	+ 2·4	24	1·05	0·05–0·02
8 f.	,,	+ 9·2	24	2·16	< 0·01

For five of the nine subjects the differential veiling glare had a measurable effect. This is shown in the accompanying table, where the mean positions chosen for the disk under greater glare, measured from the other disk, are given for these subjects. The sexes of the subjects, numbers of readings, standard errors and probabilities of the means are shown. Subject 3 tended to see the veiled disk as if farther away than the other (working by distance). Subjects 6 and 9 saw it nearer (by distance); subjects 5 and 8 saw it as if larger (by size).

Examination of the results by the analysis of variance enables us to draw the following conclusions: (*a*) The eight conditions, taken together, produced significant differences for all subjects but 4 and 7, working by distance. (*b*) The time order, indicating practice, produced no appreciable effect. (*c*) Change from variable-near to variable-far produced significant effects in subjects 3, 5 and 9, and doubtful in 7 and 8, working by distance; but only in 3 and 6 by size. (*d*) Change from variable under more to variable under less glare produced significant effects for subjects 3, 6 and 9 working by distance; but only for subject 8 by size. (*e*) Change from variable left to variable right produced significant effects for all but subject 7 (doubtful) working by distance; and for subjects 3, 6, 7 and 9 by size. (*f*) The smallness of variances due to interactions of conditions indicates that the factors mentioned above were effectively independent.

All subjects consistently over- or under-shot the mark when working for distance; by size all undershot it but subject 9, who was inconsistent.

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[1] Nature, **141**, 371 (1938).
[2] *Brit. J. Psych.*, **29**, 91 (1938).

Changes of Average Maternal Age

In a report in Nature of March 18 of an address delivered by Dr. L. S. Penrose to the Industrial Section of the British Psychological Society on February 8, the following sentence occurs: "When the birth-rate is falling, the average maternal age [average age at child-birth] will probably become greater". In support of this view it is stated that Dr. Penrose estimates the average maternal age in England at the present time at 29 years, whilst, in Japan (with a much higher birth-rate), it is said to be 26 years.

In the case of England and Wales, on account of defectiveness of birth registration prior to the passing of the new Population (Statistics) Act last year, it is unfortunately impossible to estimate accurately the average maternal age for any past period, except perhaps 1921 and 1931, for which certain approximate figures derived from census data are available. For certain European countries, however, the average maternal age at various periods may be readily calculated from published data. The following estimates are derived from figures found in Kuczynski's "The Measurement of Population Growth".

It will be seen that, contrary to Dr. Penrose's conjecture, the average maternal age falls along with the birth-rate. Reverting to Great Britain, it happens

TABLE 1. AVERAGE MATERNAL AGE.

Period	Average maternal age	Birth-rate (approximate)
Sweden		
1871–75	32·22	30·7
1891–95	31·78	27·4
1911–15	30·38	23·5
1926–30	29·67	15·9
Denmark		
1878–84	30·84	32·2
1901–05	29·98	29·0
1911–15	29·55	26·1
1926–30	28·93	18·6
France		
1892–97	29·08	22·5
1908–13	28·58	19·5
1928–31	28·10	17·9

that in the year 1855, the first year of compulsory birth registration in Scotland, the information required was relatively complete, and included age of mother. It is, therefore, possible to compute average maternal age for that year. Recently we have made an estimate of specific total fertility rates for Scotland for 1931 (based on the specific legitimate fertility rates published by the Registrar-General for Scotland in the Report for the year 1937) from which the average maternal age for 1931 may be obtained. The resulting figures are shown in Table 2, which also includes figures for England and Wales, 1921 and 1931, based on estimates published by the Registrar-General in the Statistical Review for 1932.

TABLE 2. APPROXIMATE AVERAGE MATERNAL AGE.

Period	*Approx.* average maternal age	Birth-rate
Scotland		
1855	30·2	31·3
1931	29·3	19·0
England		
1921	30·1	22·4
1931	29·6	15·8

These results show the same trend as the more accurate figures for Sweden, Denmark and France already quoted. There would seem, then, to be little doubt that in England and Wales and in Scotland, as in other European countries, the fall in the birth-rate has been accompanied by a fall, and not a rise, in the average maternal age. Closer examination shows that, in general, the fall in fertility first affects the older married women, and gradually spreads, usually in a remarkably regular fashion, to the younger age groups[1]. The effect of this in lowering average maternal age is evidently more than sufficient to balance any rise in the average age of marriage which may have occurred.

It follows that the remarks of Dr. Penrose relating to mongolian idiocy have a significance exactly opposite to that suggested in the article. With the fall in the birth-rate we should expect not an increase, but a fall in the incidence of this congenital abnormality.

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March 29.

[1] Cf. Barclay and Kermack, *Proc. Roy. Soc. Edin.*, **58**, 55–72 (1938).

Variations in Follicle Population Density in the Merino Skin

DURING research on fleece density in the merino, I was impressed with the urgent need for some form of direct observation of the skin structure in studying the follicle and fibre population. Consequently I have in the main adopted histological techniques. However, the suggestion made by Duerden[1] regarding the possible value of observations on the 'grain' surface of leather appealed to me as an even more rapid and direct approach. Through the courtesy of the Wool Industries Research Association, I was able to secure the tanned skin of a South African Cape merino which Duerden had used in his comparative zoological studies of fibre and follicle arrangement in the Ovidæ.

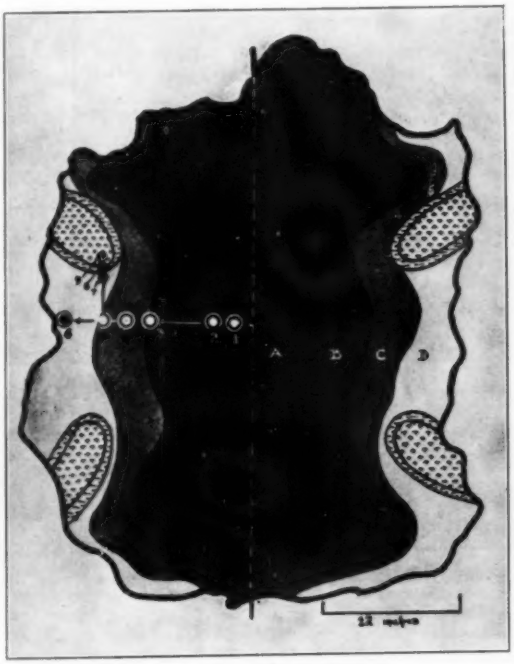

Fig. 1

After preliminary studies to establish the optimum unit area for counting, the order of accuracy of sample counts and a system of sampling, the whole skin was examined at 584 points. From this data the accompanying chart (Fig. 1) was prepared. The intensity of the colour tone is directly proportional to the follicle population density. Regional variations are defined by grouping values per unit area into four arbitrary class intervals (*A*, *B*, *C* and *D*). The chart is an accurate reduction of the original skin shape and represents rather more than 90 per cent of the fleece area in the living animal. The photomicrographs (Fig. 2) correspond numerically to the points indicated on the chart, the magnification (× about 6) being uniform. It will be noted that not only is there a progressive reduction in follicle population per unit area in a dorso-ventral direction but also that, corresponding with this reduction, changes

occur in the arrangement of follicles. The dense and more or less uniformly distributed population of the dorsal regions assumes an increasingly distinct linear arrangement ventrally (Sites 1–6). Passing across the margins of the well-defined inguinal and axillary regions (Sites 7–9) these rows become dispersed into isolated groups and single follicles. It is in such regions that the most obvious trace of the primitive trio grouping can be observed. With reduction in density an increase in mean follicle size occurs. It would seem that the values for density of follicle population are arranged with marked bilateral symmetry about the dorsal longitudinal median line. The main gradient appears to be dorso-ventral, though a fairly well-defined antero-posterior gradient may usually be observed. The inguinal and axillary regions constitute minor gradient fields within the main system but do not belong to the fleece area of economic interest. The gradient systems noted here are confirmed in histological studies.

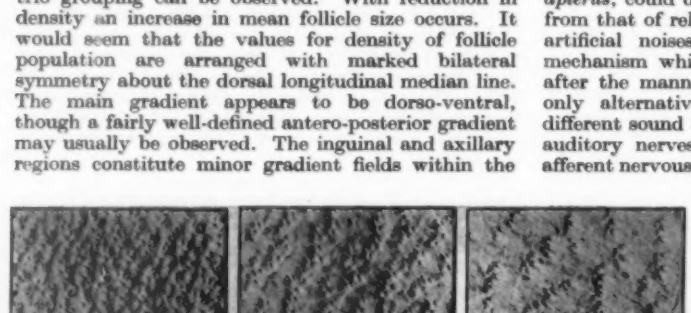

Fig. 2

These observations support those of Wildman[2] and, considered in relation to embryological and histological studies, may have considerable significance in the development of reliable methods of fleece analysis, especially in regard to the problem of sampling. Further studies on this class of material are suggested in view of the encouraging results so far obtained.

This work was done during my tenure of the Walter and Eliza Hall fellowship in veterinary science at this University.

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University of Sydney.
March 28.

[1] Duerden, J. E., *Bull. Wool Ind. Res. Assoc.*, **5**, 3, 24 (1936).
[2] Wildman, A. B., Nature, **139**, 285 (1937).

'Frequency Discrimination' in Insects: a New Theory

It has long been known that some at any rate of those insects which possess tympanic organs are able to discriminate between sounds which differ by a factor other than intensity. Regen[1], for example, showed that a long-horn grasshopper, *Thamnotrizon apterus*, could distinguish the stridulation of its own from that of related species, and either from various artificial noises. No insect has any peripheral mechanism which would permit harmonic analysis after the manner of the mammalian cochlea. The only alternative basis for discrimination is that different sound qualities shall be represented in their auditory nerves by different temporal patterns of afferent nervous impulses. But here a limit is imposed by the refractory period of the nerve fibres, and frequency discrimination on this basis would only be expected to be possible for frequencies up to a few hundred cycles per second.

It has been shown[2,3] that the tympanic organs of insects do not respond at all to such low frequencies, nor is it to be expected that they would, except at enormous intensities, for the area of the tympanic membrane is very small. Maximum sensitivity is found to occur for frequencies of 5000–20,000 c.p.s., and at any frequency the nervous response to a pure tone (if it can be obtained at all) is asynchronous, that is, the nervous activity in the auditory nerve is random and no temporal pattern can be detected. There is here an apparent paradox that the neural mechanism of discrimination seems to be suited to sound frequencies which the insect, by reason of its small size, can neither radiate nor detect.

Our experiments indicate that the way out of this impasse which has been adopted by these insects is closely analogous to the device which has rendered wireless telephony possible. The high frequencies emitted by a stridulating insect act as a carrier for a low-frequency modulation, and it is the latter which probably characterizes the sound to an insect auditor.

We connected a surviving preparation of the tympanic organ and auditory nerve of a locust to an amplifier and oscillograph so that the nature of the nervous response could be observed. The preparation was exposed to a sound source which would yield pure tones of any desired frequency up to 10,000 c.p.s. These pure tones could be modulated sinusoidally in amplitude at a second chosen frequency. Modulation from 0 per cent to more than 90 per cent could be obtained without serious deformation of the modulation envelope, using a device which has been described in detail elsewhere[4]. As was to be expected[2] the preparation was completely insensitive to pure tones at low frequencies (50–300 c.p.s.), and, though very sensitive to a pure tone of 8000 c.p.s., the latter elicited a completely random response. But in

response to an 8000 c.p.s. tone modulated at any frequency up to 300 p.s. the nervous discharge consisted of bursts of activity at the modulation frequency. The very characteristic pattern of impulses was found to be quite unaltered by large changes in the carrier frequency, and it is reasonable, therefore, to conclude that such high frequencies have in themselves no significance for the insect. Their function is only to carry the modulation precisely as audio-frequency modulation is carried in wireless telephony by high-frequency electromagnetic waves. In both cases, the radiation and reception of low audio frequencies is impracticable and for analogous reasons.

It is of interest to note the sharp contrast with human hearing. The human ear is about as sensitive as that of this insect at 8000 c.p.s., and deep modulation of such a tone may impart to it a perceptibly trill-like character. A human observer, however, though he readily perceives small changes in the carrier frequency, is quite insensitive to large variations in the modulation frequency provided that the latter is not so low that discrete beats are perceived.

On the hypothesis outlined above, the process of discrimination of the quality of a given sound by an insect with a tympanic organ is quite different in principle from frequency discrimination in the strict sense of human physiology. It is therefore possible to explain a number of puzzling observations which have been recorded. For example, Regen[5] showed that a virgin female cricket will regularly approach a telephone which is transmitting the chirruping of a male, even when the distortion is so gross that the sound is unrecognizable to the human ear. It is evident that distortion of the kind which would be introduced by a telephone, such as partial rectification, frequency discrimination and the introduction of odd harmonics will not alter the modulation frequency. Provided, therefore, that enough high-frequency carrier gets through the telephone to excite the female's tympanic organ at all, the pattern of nerve impulses corresponding to the modulation frequency will appear in her auditory nerve. Conversely, the ability of some insects to distinguish between sounds which are identical to human ears is also explicable if it can be shown that such sounds are differently modulated though the carrier frequency is the same.

A full account of the experiments will be published at a later date.

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Sponge Mortality in the Bahamas

A HEAVY mortality broke out among the commercial species of sponge (Wool, Velvet, Grass, Reef, Yellow and Hardhead) on the natural banks in the waters of the Bahama Islands early in December 1938. The mortality was recorded earliest among the eastern islands of the Colony and spread rapidly westwards, until by the end of February 1939 there remained no sponge-bearing bank unaffected in the Colony. It is reported to have spread to the north coast of Cuba in February and Key West, Florida, in March. The mortality rate in most of the areas affected in the Bahamas is high (70–95 per cent).

The investigations, conducted jointly in the Bahamas by the United States Bureau of Fisheries and the Bahamas Sponge Fishery Investigations Department, were carried out along the following lines.

(1) Chemical and hydrographical observations carried out by Dr. C. Leslie Smith show on the sponge beds themselves (down to 8 metres) a wide salinity range (36·4–43·6 per mille), *p*H (8·15–8·35), phosphate (undetectable to about 5 mgm. P_2O_5/m.^{3}), silicate (undetectable to 220 mgm. SiO_2/m.^{3}), oxygen (90–110 per cent saturation), excess base (2·10–2·90 milli-equiv./litre), calcium (440–550 mgm. Ca/litre, and as much as 400 per cent saturation) and a temperature range of 22° – 28° C. These figures are consistent with results obtained regularly in this area over the last two years, and the main features (temperature-salinity correlation curve, thermocline and oxygen-poor layer) of a deep ocean channel between the islands remained unchanged down to 1,250 metres. As much as 60 mgm./m.^{3} ammonia nitrogen was observed as compared with the normal level of 20 mgm./m.^{3}; but this is attributed to the large numbers of rotting sponges on the beds nearby. Dr. Galtsoff finds a relatively high copper content especially in inshore areas (between 2 and 8 mgm./m.^{3}), but neither this nor any other observed hydrographical factor is regarded as responsible for the mortality.

(2) Examination of plankton collected by means of No. 20 silk net in the inshore areas of Andros Island and on the Little Bahama Bank disclosed the general paucity of microscopic life in the sea, typical for these waters, and is consistent with the observations over two years in the Bahamas of Dr. Walton Smith. This is correlated with the deficiency of the principal nutrient salts. Microplankton samples obtained by centrifuging small volumes of water also failed to reveal the presence of any minute forms, which might have been responsible for the destruction of sponges. With the exception of the inshore waters in close proximity to sponge kraals, the microplankton was extremely poor, comprising primarily bacteria, shown by Drew to be particularly abundant in this area[1].

(3) The records of a number of observers indicate that the sequence of infection was from east to west following the trend of water movements within the Colony.

At the same time the spread of the disease was recorded more closely from the research vessel, on the largest single sponge-bearing bank in the Bahamas. This bank lies to the west of Andros Island, and the sponge-bearing part of it measures 120 nautical miles from north to south, and between 45 and 70 miles east to west. Seven successive surveys show that the infection spread on this bank in an ever-widening area, from the north-west extremity of Andros. The infection followed the general trend of known wind-influenced water movements. The intensity of the infection on its advancing front suffered no diminution, such as might be expected from the dilution or dispersal of a chemical or physical factor. The spread was consistent with the possibility of transmission over the area of a water-borne biological agent.

(4) Biological investigations have been carried out by Dr. Paul S. Galtsoff and Dr. F. G. Walton Smith. Fungus-like filaments, first observed early in March by Dr. Galtsoff, have been found constantly in all diseased sponge tissues examined. The filaments have not been found in healthy sponge tissues, nor in the remains of sponges which have been long dead. They are particularly abundant in the marginal zone between the newly dead and living tissues of diseased sponges. The infection spreads gradually through the tissues, starting often from an origin inside. The symptoms contrast with those observed when death has ensued from other known factors observed during the previous two and a half years. The infection of the micro-organism and the mortality are confined only to a few species of sponge (including unfortunately all the six commercial species), and have not been observed to affect any other form of marine life.

It has been possible to infect Reef and Wool sponge with the filaments, by contact with fragments of infected sponges of the same species.

Attempts are being made to have the organism isolated and identified. A full account of this and further projected work will be published elsewhere.

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Growth of *Borrelia duttoni* in the Developing Chicken Embryo

The value of the developing egg in the study of many viruses is now well established, and the chicken embryo method of passage has proved of great use in propagating these viruses, which, as a rule, can only be grown in tissue culture, and not in the ordinary bacteriological culture media. Many members of the spirochætal class of organism can only be grown, with great difficulty, in special media, and it was therefore decided to attempt the growth of a spirochæte in the developing chicken embryo.

The organism chosen was that responsible for African relapsing fever, *Borrelia duttoni*, for this cannot readily be grown in culture, but is usually maintained by passage from mouse to mouse.

The method was simply the inoculation of a fertile hen's egg, which had been incubated for a certain period, usually eight to twelve days, at the temperature customary for such incubation, namely, 38·5° C. After this preliminary period, which was necessary to ensure that the embryo inside was at a suitable stage of development, the egg was inoculated with a small amount of mouse blood, the mouse having been infected a few days previously with the spirochæte of relapsing fever. Having introduced the inoculum into the egg, the site of inoculation was sealed off with sterile paraffin, and the egg now incubated for a further interval of three to four days, at the ordinary bacteriological temperature, that is, 37·0° C. At the end of this time, the egg was opened and the contents examined by microscopical and other methods.

When such an egg was opened and the fluid inside inspected by the dark-ground illumination technique, it was found that many actively motile, living spirochætes were present. These findings were easily confirmed by inoculation of the material into mice, for on examining the mice forty-eight hours later, it was found that their blood contained large numbers of the organism.

A second batch of eggs, after preliminary incubation, was then inoculated with the material from the first eggs, and again, after three days further incubation, these were found to contain living spirochætes, both by visual examination and by mouse inoculation.

The process of egg passage was then continued and a third sample of developing eggs, this time only seven days old, was infected with a small drop of the fluid from the second passage ones, and these, on being inspected by the dark-field method, showed a very large number of spirochætes to be present, particularly in the blood of the embryo, with a very much smaller number in the rest of the egg contents. Animal inoculation again proved that these spirochætes had not lost their pathogenicity towards mice.

A fourth passage experiment gave precisely similar results.

Further work is in progress, with the view of determining the effect of continued egg passage on the characters of the spirochæte concerned.

It is interesting to note here the effect of the spirochæte on the embryo. If viruses are grown in eggs, the usual action is either to kill the embryo, or, alternatively, to produce local lesions on the chorio-allantoic membrane, with little or no effect on the embryo. *Borrelia duttoni*, however, has a different action, for in the four passages described above no naked-eye change could be observed in the membrane nor was the embryo killed. Examination of the constituent parts of several eggs appeared to show that the lesion produced took the form of a blood invasion. This finding is similar to the result produced in man and susceptible animals, for in them there is a definite infection of the blood stream, easily demonstrated, as a rule, by blood films.

Since writing the above, my attention has been directed to the work of Morrow and his colleagues[1], who have cultivated *Leptospira icterohæmorrhagiæ* on the chorio-allantoic membrane.

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Genetic and Cytological Interference

Paired meiotic chromosomes may have their four chromatids or strands involved in a variety of ways in two adjacent chiasmata. In most studies of chiasmata the materials have not been favourable enough to permit the tracing of all four strands through two or more chiasmata. We have recently been able to do this in forty-eight complete pollen mother cells of *Trillium erectum*, and have observed therein eight types of chiasma pairs. These are shown diagrammatically in Fig. 1 together with their frequencies and interstitial lengths (alternative one-plane representations of these three-dimensional configurations are here neglected).

Clear separation of chromatids and reduction of coiling at metaphase may be obtained in *Trillium*

by various treatments. An extreme example is shown in Fig. 2 (one of five photomicrographs taken at different optical levels in a single cell), in which the five pairs of chromosomes may each be seen to have four very widely separated chromatids. These can be traced throughout their length in the serial optical sections. The material from which the data for Fig. 1 were obtained was less drastically treated.

	a	b	c	d	e	f	g	h	Totals
	Frequencies								
Melanoplus (from Hearne and Huskins, 1935)	27	26	9	3					65
Trillium (preliminary data, Huskins, *et al.*, 1937) ..	33	15	1	1					50
Trillium (new data) ..	190	144	34	16	3	2	1	1	391
Total	250	185	44	20	3	2	1	1	506
	Average Lengths in Microns								
Melanoplus	3·5	4·8	5·1	3·9					
Trillium (prelim.)	2·3	3·3	5·7	3·1					
Trillium (new)	2·5	3·7	3·6	4·7	4·0	3·0	10·0	10·0	
						5·4			

Fig. 1.

DIAGRAMMATIC REPRESENTATION OF THE EIGHT CYTOLOGICALLY DISTINGUISHABLE TYPES OF CHIASMA PAIRS OBSERVED IN *Trillium erectum*.

Hearne and Huskins[1] found in *Melanoplus femur-rubrum* 71 compensating pairs of chiasmata (those in which the paired strands separated by one chiasma were reunited by the second) and 35 non-compensating pairs. Sax[2] classified their figures into four types of chiasma pairs and showed that these did not occur in the proportions primarily expected on existing theories of crossing-over. A modification of the Wilson-Morgan theory which he proposed gave a better fit for these and other data than did Belling's or Darlington's theories of their simple interpretation.

Melanoplus chiasmata are terminalized during the meiotic prophase and their position at metaphase therefore gives little indication of their place of formation. *Trillium erectum*, having little or no terminalization, provides data on both chromatid relationships ('chromatid interference') and on the distances between chiasmata ('chiasma interference'). Fig. 1 shows that the least frequently occurring types of chiasma pairs are those having the greatest number of chromatid twists and the greatest interstitial length. Analysis of the more frequently occurring types in relation to theories of crossing-over involves assumptions which are the result of calculations too extensive to be entered into here. In brief, they also suggest an association between frequency, interstitial length, and complexity of chromatid relationships.

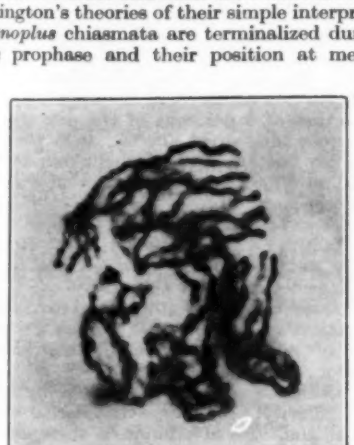

Fig. 2.

METAPHASE OF *Trillium erectum* SHOWING REDUCTION OF COILING AND EXTREME SEPARATION OF THE FOUR CHROMATIDS IN EACH OF THE FIVE BIVALENTS.

Our analyses of Lindegren and Lindegren's[3] *Neurospora* data, and Beadle and Emerson's[4] and Bonnier and Nordenskiold's[5] data from attached-*X* chromosomes in *Drosophila*, together with the observations of chiasmata in *Melanoplus* and *Trillium*, seem to permit the following generalization: A chromatid is most likely to be involved in two adjacent cross-overs or chiasmata if the distance between these is short. In other words, chromatid interference occurs as well as chiasma interference, and it varies with distance. Further study has therefore confirmed and extended earlier conclusions from this laboratory[1,6]. Details will be published shortly; they indicate certain new essentials for any hypothesis concerning crossing-over and suggest possible mechanisms, though it appears doubtful if sufficiently comprehensive data (particularly biophysical) yet exist for the inductive formulation of a general theory.

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Influence of Colchicine on the Sexually Induced Colour Change of *Rhodeus amarus*

IN previous communications, I have given an account of some experimental evidence pointing to the intervention of hormonal influences in the action of colchicine in plants[1,2,3]. I have also suggested[3] that a similar mechanism of action may be, among others, responsible for the mitotic impetus described by A. P. Dustin and his school[4] in the germinative zones of animals treated with this alkaloid. This view seemed to be further supported by the extraordinary number of mitoses observed by Allen, Smith and Gardner[5], Bastenie and Zylberzsac[6], and many others, in the sexual organs of animals treated with sex hormones combined with colchicine. It seemed therefore worth investigating whether colchicine, hitherto regarded merely as a revealer of

these hormonally induced mitotic processes, can also exercise, either independently or synergetically with endocrine products, a hormonal action in animals.

Rhodeus amarus males are known to produce in the breeding season a characteristic colour change (*Hochzeitskleid*). This effect can also be obtained before or after the breeding period by the administration of sexual hormones[7]. About ten-months old *Rhodeus* males weighing between 2 and 3 gm. were used about six weeks before their normal breeding period in Hungary. The fishes were divided into five groups and treated as follows:

The first group was placed in a large beaker containing a 0·075 per cent aqueous solution of colchicine. The second group was given intraperitoneal injections of 7·5 mgm. of testis hormone ('Orchitic' Choay) dissolved in 0·075 ml. of physiological serum, and was then placed in a beaker filled with tap water. The third group, similarly injected, was placed in a solution of colchicine of the above concentration. The fourth group received by intraperitoneal injections 0·075 ml. of tap water and was placed in tap water. The fifth group, untreated, served as control, and was placed in tap water, as above. Eighty-five minutes after the beginning of the treatments the animals were transferred into aquariums provided with running water.

Ten minutes after the beginning of the treatment, the animals of the first and second group showed already the first symptoms, consisting in a ruby red coloration of the iris. The animals of the third group manifested the effects of the combined treatment moreover by a carmine red coloration of the anal fin and continued to display, throughout the treatment, the successive stages of the colour change at a more accelerated rate than those of the first and second group. The full *Hochzeitskleid* of great intensity was produced by these animals within *ninety-five minutes*, calculated from the beginning of the treatment, whereas the fishes treated with either colchicine or the hormone alone did not display this full effect until about *twenty hours later*. It was also observed that the intermediary stages of the colour change were attained faster by the animals injected with the testis hormone alone than by those treated with colchicine alone. (This was to be expected as the pharmacological effects of colchicine are also produced after a prolonged period of incubation.) The full *Hochzeitskleid* of all the treated *Rhodeus* was maintained during about forty-eight hours and faded thereafter gradually, until it had practically disappeared about seven days after the beginning of the experiment. No colour change was observed throughout the experiment in any of the untreated or of the water-injected control animals.

These results demonstrated in consequence clearly that: (1) although displaying its effects somewhat more tardily than the hormone, colchicine produces effects of the same intensity; (2) colchicine acts in a high degree synergetically with the hormone.

A supplementary proof of the above gradation of the effects was furnished by an exactly corresponding gradation of the oxygen consumption of the treated and control animals, as measured by H. Mann[8].

It remained to test whether the above effects were not rather the manifestations of a direct response of the pigment cells, due to purely nervous stimulation, without necessarily involving the intermediary of a hormonal mechanism of action. For this purpose, other fishes (*Leuciscus rutilus* and *Perca fluviatilis*) known to have lipochrome pigments similar to those of *Rhodeus*—but displaying no sexually induced colour change (*Hochzeitskleid*)—were treated with colchicine and sex hormones as above. No colour change was, however, observed in any of the treated animals. Although indirect, the value of this test was made even more plausible by the fact that the respiratory metabolism of these animals has shown, according to the treatment given, an exactly analogous gradation to that previously observed in *Rhodeus*[8].

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Alimentary Exudative Diathesis, a Consequence of E-avitaminosis

In a previous communication[1], we described a symptom which could be produced in chicks by feeding them an artificial diet in which the protein had been thoroughly extracted by alcohol. The symptom consists in large accumulations of blood plasma under the skin, originating from inflamed and hyperæmic capillaries in the connective tissue, notably the fat tissue. This condition was termed 'alimentary exudative diathesis', and it was shown to be a deficiency disease which could be prevented by alfalfa, and petrol-ether or alcohol extracts from alfalfa.

We have now studied the occurrence and nature of the anti-exudative factor. A relation with nutritional factors known to influence capillary permeability could be excluded with absolute certainty, and the same holds true for the possible relation to vitamin K. Wheat germ and dried hips were found to give protection against the disease when given in the proportion of 5 per cent of the diet and to be better sources than dried alfalfa. 0·15 per cent of the epiphasic fraction of an alcoholic extract of hips was found to afford a better protection than 2 per cent of wheat-germ oil.

A direct test of *d*, *l*-α-tocopherol uncombined or in the form of the acetate (supplied by F. Hoffmann, La Roche and Co., Basel) revealed the fact that vitamin E protects against the disease.

The production of alimentary exudative diathesis in other animals than chicks as well as the possible existence of related conditions in man is under investigation.

It is possible to estimate vitamin E by its anti-exudative activity. Exudative diathesis is inhibited by smaller quantities of vitamin E than encephalomalacia in chicks receiving a fat-rich diet, a disease which may also be used for the biological assay of vitamin E[2].

By the new method we have found that the lipoid of hips is much richer in vitamin E than wheat-germ oil.

Experiments are being carried out in order to settle the question whether vitamin E is also identical with the light white casein factor of Coward *et al.*[3], a possibility which might be supported by the fact that an exhaustive treatment with alcohol is necessary for the complete removal of vitamin E from casein used in artificial diets.

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Role of Manganese in the Biological Synthesis of Ascorbic Acid

Guha and Ghosh[1] found that rat liver incubated with mannose produced ascorbic acid, and followed it up by showing that parenteral administration of mannose also produced ascorbic acid in the rat tissue and notably in the liver. Euler *et al.*[2] were unable to confirm the *in vitro* results, which was explained as due to the absence of molecular oxygen[3] as Euler's experiment was made in an atmosphere of nitrogen. However, Hawthorne and Harrison[4] and Klodt[5] also could not confirm Guha's results *in vitro* or *in vivo*.

It has now been found that manganese is a determining factor in the synthesis of ascorbic acid by rat tissue. The experiments of Hawthorne and Harrison (*loc. cit.*) were repeated with this modification, that the Ringer-Locke solution in which the liver was incubated with mannose contained 0·02–0·001 per cent manganese as manganese chloride. The concentration of manganese in the incubated mixture thus ranged from 0·01 to 0·0005 per cent. In my series of experiments 0·001–0·0005 per cent of manganese in the incubated mixture has been found to be most favourable for the synthesis of ascorbic acid *in vitro*. It has also been found that galactose, like mannose and glucose to a less extent, may also act as precursors. In *in vivo* experiments, the mannose solution given intravenously contained 0·001 per cent manganese as the chloride. Typical results are given in the accompanying table.

In vitro			*In vivo*	
% Mn in R.-L.	Sugar	Mgm. ascorbic acid per gm. liver	Mgm. ascorbic acid per gm. liver	
			Control (N.S.)	Mannose + Mn
0·002	Mannose	0·22	0·25	0·32
0·002	Galactose	0·21	0·21	0·29
0·002	Glucose	0·19		
Nil	Mannose	0·16		
Nil	Nil	0·16		

Details are being published elsewhere.

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[2] *Biochem. Z.*, **282**, 399 (1935).
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[4] *Biochem. J.*, **31**, 1061 (1937).
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Points from Foregoing Letters

F. Adler and H. von Halban, jun., discuss the energy liberation of a nuclear reaction chain, consisting of successive fissions of the uranium nucleus by slow neutrons, and maintaining itself by the neutrons liberated in the fissions. The addition of a small quantity of cadmium to the system provides the possibility of controlling the energy liberation. The system will become stable at a temperature which is characteristic for the chemical composition and the dimensions of the system.

T. Bjerge, K. J. Brostrøm and J. Koch have measured the decay curves of the fission products of uranium bombarded with fast and slow neutrons, and have carried out similar measurements on the fission of thorium. The decay curves with either fast or slow neutrons had the same shape, showing that the fission processes give rise to great numbers of different nuclei, the individual characters of which are smoothed out in the decay curves.

Tracks, on photographic plates with a thick coat of emulsion, of recoil nuclei produced by the action of neutrons from uranium have been recorded by L. Myssowsky and A. Jdanoff. Their range is very close to that of α-particles of uranium. The number of tracks of recoil nuclei having ranges greater than 1·5 cm. in air is equal to about one hundred nuclei per square centimetre per minute, in fair agreement with the results of Frisch.

The emission of short-range groups of α-particles from oxygen, nitrogen and fluorine under proton bombardment has been discovered by W. E. Burcham and C. L. Smith. The group from fluorine follows a resonance excitation curve similar to that obtained for the γ-rays also produced by bombarding fluorine with protons. The groups from oxygen and nitrogen are interpreted as due to disintegrations of rare isotopes of these elements.

R. C. Majumdar and D. S. Kothari state that if the initial energy of a meson exceeds two thousand million electron volts ($2Mc.^2$) it could be transformed into two heavy particles, a proton and a neutron. It is possible that the protons and neutrons found in cosmic rays may arise in this manner.

A group of investigators from Osaka Imperial University have redetermined the isotopic masses of carbon and nitrogen by comparison of the doublets CH_4—O and CH_2—N and find the values 12·00394 and 14·00761 respectively.

F. W. Aston discusses the difference between his own value for the isotopic weight of ^{12}C and those obtained by other workers using double focusing mass-spectographs. He points out that while the accuracy claimed is much greater than his own, there are results which suggest the possibility of systematic error. The discrepancy remaining is, however, very small.

Spectra of the 4046 radiation of mercury, scattered by benzene, acetic acid, salol and glycerine, are submitted by Sir C. V. Raman and C. S. Venkateswaran, showing that glycerine behaves in this respect like an

amorphous solid. These observations, and also the behaviour of ultra-sonic waves in viscous liquids, suggest that, for mechanical disturbances of sufficiently high frequencies, a liquid behaves essentially as a solid.

S. Shalyt states that nickel, cobalt, ferrous and chromium chlorides, the magnetic susceptibility of which at the temperature of liquid hydrogen depends on the intensity of the field, also show jumps in the specific heat and that these phenomena are related. They may be explained by the quenching of the orbits of metallic ions in the electric field of the crystal.

A. H. Cooke and R. A. Hull describe new experiments on pumping liquid helium to low temperatures. Using a pierced membrane to restrict the creeping of the helium II film, they reach by simple means temperatures previously only attainable with elaborate apparatus.

S. B. Hendricks states that aluminium silicate layers in the biotite-like micas are stacked in a variety of ways preserving twelve-fold co-ordination of interlayer potassium ions. Incomplete filling of octahedral co-ordination positions within a layer of muscovite results in a distorted structure with a unique requirement on layer stacking. Diffuse scattering of X-rays by some biotites is a result of random combination of types of stacking. Variation in optic axial angles of micas is largely due to differences in structures.

C. H. Douglas Clark has deduced some simple relations between the heat of dissociation D, the internuclear distance r_e and the bond order x of carbon-carbon linkages. The relation between D and r_e was independently investigated by Fox and Martin by a different method, with the same conclusion. Satisfactory agreement with experiment is obtained.

Excellent optical interference figures of angular aperture up to 120° are obtained by H. E. Buckley by replacing the whole lens-system of the ordinary projector, between crystal and screen, by a single 'Polaroid' filter, of 1½ in. to 2 in. diameter, close up to the crystal.

By observations on the clouds rising from active areas on Mt. Tongariro and White Island, N.Z., S. H. Wilson estimates the amounts of water vapour emitted to the atmosphere from fumaroles at these two localities.

It is suggested by C. C. Caldwell and R. J. W. Le Fèvre that the stable configuration of benzil (Ph.CO.CO.Ph) is one in which the two Ph.CO. units lie in planes, which are approximately at right angles to one another.

E. H. Neville submits that there is no basis in mathematics alone for certain comments made by D. P. Riley and I. Fankuchen on their recently constructed vector map of a cyclol skeleton.

In an experiment on binocular vision through a veiling glare comparable with illuminated fog, B. Babington Smith and R. W. Pickford found that the effect of differential veiling glare on the apparent relative distances or sizes of objects seen through it is very variable from subject to subject. It is much affected by conditions such as the rightward or leftward and near or far initial positions of the variable object, and by the presence of greater glare over the variable or standard—conditions which might be thought irrelevant.

R. S. Barclay and W. O. Kermack point out that, contrary to certain opinions, the average maternal age in various European countries for which figures are available has decreased while the birth-rate has been falling. The evidence indicates that a similar fall has occurred also in Scotland and in England and Wales during recent decades.

H. B. Carter reports a detailed study of regional variations in the density and arrangement of the follicle population observed on the 'grain' surface of the tanned merino skin. The results indicate the existence of an antero-posterior gradient in population density for which evidence had previously been presented by Dr. A. B. Wildman, but it is shown that in the present case this is subsidiary to the dorso-ventral gradient. This is illustrated by a chart and photomicrographs.

R. J. Pumphrey and A. F. Rawdon-Smith present evidence that the ability of certain insects to discriminate between different sounds is due to the rectifying action of the tympanic organ, which permits the activity in the auditory nerve to be synchronous with the amplitude modulation imposed on a carrier frequency lying within the insect's auditory spectrum. This difference from the mammalian method of frequency discrimination provides a satisfactory explanation of previously irreconcilable experimental observations.

The incidence and spread of a mortality among sponges in the waters of the Bahama Islands is reported by Paul S. Galtsoff, H. H. Brown, C. Leslie Smith and F. G. Walton Smith. Evidence is adduced which suggests that a fungus-like organism may be responsible for the mortality.

The spirochæte of African relapsing fever, *Borrelia duttoni*, has been successfully propagated by R. Knight Oag in the developing chicken embryo for four serial transfers, and a profuse growth of the organisms obtained. The spirochætes do not kill the embryo or produce visible lesions in the chorio-allantoic membrane, but invade the blood-stream of the embryo. Throughout the series of egg passages the virulence of the organisms for mice has remained unaltered.

Eight types of chiasma pairs have been observed by C. L. Huskins and H. B. Newcombe in the pollen mother cells of *Trillium erectum*. They indicate that a chromatid is most likely to be involved in two adjacent cross-overs or chiasmata if the distance between these is short.

L. Havas reports that treatment with colchicine effects the sexually induced colour change (*Hochzeitskleid*) in *Rhodeus amarus* males, and this, in the same time (20 hours) as treatment with the testis hormone. A combined treatment with colchicine and testis hormone produces, however, the full *Hochzeitskleid* in ninety-five minutes. The oxygen consumption of the animals showed the same gradation of effects.

H. Dam and J. Glavind point out that the alimentary exudative diathesis in chicks can be prevented by synthetic *d*, *l*-α-tocopherol, and by natural sources of vitamin E.

M. N. Rudra has found that incubation of rat liver with mannose, galactose or glucose in Ringer-Locke solution and phosphate buffer containing manganese as chloride produced ascorbic acid in the liver. Intravenous injection of mannose in manganese solution also produced ascorbic acid in the liver.

News and Views

Prof. H. H. Dixon, F.R.S.

On May 19, Prof. H. H. Dixon reaches his seventieth birthday, an occasion upon which all his friends would like to offer him their best wishes. In collaboration with his lifelong friend, the late Prof. J. Joly, Dixon developed the cohesion theory of the ascent of sap. This classical work, published in 1894, was the precursor of many physiological and morphological papers, which led to his election to the Royal Society in 1908, and to the award of the Boyle Medal of the Royal Dublin Society in 1917. In 1904, he was appointed to the University professorship of botany in Trinity College, Dublin, a position which he, happily, still continues to adorn. During his tenure of the chair, the new School of Botany (1907) and the new Herbarium (1912) were erected, both largely due to Prof. Dixon's enterprise and the late Lord Iveagh's generosity. His early morphological and cytological work enriched his laboratory with many beautiful slides of nuclear division, and, during the Great War, he published an exhaustive examination of the varieties of mahogany, many of which were used in aeroplane propellers. In 1937, he delivered the Croonian Lecture before the Royal Society in which he reviewed the theory of the ascent of sap. This lecture was illustrated with his distinctive experimental ingenuity. In recent years, among other subjects, he has investigated the alterations in the permeability of plant cells due to electrical stimuli and shown how closely they may be paralleled by the changes in resistance of certain emulsions. His pupils, including many medical men, scattered widely over the Empire, will long remember with affection the tutelary genii of the Botany Lab. T.C.D., "Botany Dick" and his "Mate" Mr. Joe Murray.

Dr. D. A. E. Garrod

The appointment of Dr. Dorothy Annie Elizabeth Garrod as Disney professor of archæology in the University of Cambridge in succession to Prof. E. H. Minns, who will retire on October 1 next, will be welcomed by all archæologists as no more than the due recognition of a remarkable career of archæological research and discovery. It is also the first appointment of a woman to a professorial chair at Cambridge. Miss Garrod, who is the daughter of the late Sir Archibald Garrod, Regius professor of medicine in the University of Oxford, was born in May 1892, and she is now director of studies in archæology and anthropology (Section A) of Newnham College. In her prehistoric studies, Miss Garrod has been a faithful disciple of the Abbé Breuil, but her discipleship has in no way cramped her in the development of a strong and independent line of thought in archæological theory, of which the germ is to be seen in her first important publication "The Upper Palæolic Age in Britain" (1926), and came to full fruition in her remarkable analysis of palæolithic culture in a reorientation, which formed the subject of her striking presidential address to the Prehistoric Society in 1937. To a wider public Miss Garrod is known as the director of a succession of successful archæological excavations at Gibraltar (1925–26), in Southern Kurdistan (1928), in the caves of Mount Carmel, Palestine (1929–34), and Bulgaria (1938), which have produced among other results the discovery at Gibraltar of a second Neanderthal skull, and in Palestine have traced early man through successive phases of prehistoric culture back to Acheulean times, as well as added a new culture and race to the peoples of that region at the close of the palæolithic period. Miss Garrod's success as an excavator is equalled by the skill and lucidity with which she has described her discoveries. In 1927 she was a member of the International Commission which reported adversely on the Glozel antiquities; and in 1936 she occupied the presidential chair of the Anthropological Section of the British Association.

Sir Clement Hindley, K.C.I.E.

Sir Clement Hindley has been elected president of the Institution of Civil Engineers for 1939–40 and will take up his duties on November 7. Sir Clement joined the Engineering Department of the East Indian Railway in 1897 and his career as a railway engineer in India culminated in his appointment in 1922 as the first Chief Commissioner of Railways for India. On retirement from India in 1928, Sir Clement was appointed as the first chairman of the Racecourse Betting Control Board, and he has recently been lent temporarily by the Board to the Home Office to act as chairman of the Professional Advisory Committee (Shelters) in connexion with air raid precautions. The organization of scientific research is a matter in which Sir Clement has taken a great interest and he was a member of the Advisory Council for Scientific and Industrial Research during 1932–37. He has been chairman, since its inauguration in 1935, of the Institution of Civil Engineers Research Committee, which has been responsible for carrying out many important engineering researches in connexion with soil corrosion of metals and cement products, pile-driving, velocity formulæ, special cements for large dams, fish-passes, steel structures, repeated stresses in structural elements, earthing to metal water pipes and mains, breathing apparatus for use in sewers, etc. His election as president of the Institution of Civil Engineers is both a fitting acknowledgment of his eminence as an engineer and a mark of recognition of the importance of research in engineering.

Conference on Air-raid Shelters

THE Government has now announced its decision on the subject of providing heavily protected shelters against air attack for large numbers of the civil population, and it has come to the conclusion that such a policy is impossible as well as undesirable. There is little doubt that the demand for deep tunnels and 'focal' shelters of the type advocated by the Finsbury Borough Council arose in consequence of statements made by superficial observers in Spain that such shelters were available for many of the inhabitants of Barcelona and other large cities, and that their provision was mainly responsible for the small number of casualties that had resulted from the more recent air raids in Spain. This, too, in spite of the fact that the statements were contradicted in January last by the person in the best position to know, namely, the chief air raid officer in Barcelona. That official was reported in *The Times* to have said that only about thirty thousand persons out of a total of nearly two millions in Barcelona had such shelters available, and that only about half the population had shelters of any sort, which consisted chiefly of cellars in private houses, and covered trenches. They had learnt from experience the necessity of evacuating the areas that were made special objects of attack, such as the docks, and of clearing the streets and of getting under cover of some sort.

THE public was, however, misinformed; and the demand for deep shelters became so insistent that, although the Lord Privy Seal has scarcely concealed his disbelief in the necessity for them, he convened a conference under the chairmanship of Lord Hailey to consider the whole matter. In its report (H.M. Stationery Office, 6*d*.) the Conference has examined the chief proposals put forward and has rejected all of them, giving half a dozen reasons for the conclusion reached, each one of which would have been sufficient to justify the verdict. The report concludes with a warning against a too ready acceptance of some of the estimates of cost put forward, and by expressing the belief that most British citizens would prefer to count upon less effective protection at their own homes, even if this made no pretence of warding off direct hits or near hits of bombs.

Emergency Preparations in the Event of War

THE Minister of Health has forwarded to all local authorities concerned in the Government's Evacuation Scheme in England and Wales a communication asking them to work out in detail their plans for the evacuation of school children and others who are to receive priority under the scheme (Ministry of Health Circular 1800. H.M. Stationery Office, 1*d*.). Enclosed with this communication is a memorandum (Memo. Evacuation No. 4, 3*d*.) indicating the general lines of the procedure that would be necessary in an emergency and the problems likely to arise, and discussing transport arrangements, arrangements at detraining stations and details of reception, and giving practical advice for householders and others. Authorities are recommended to make full use of all voluntary agencies that might be useful, and it is stated that the Government does not intend that the operation of the scheme should result in any additional burden on the local rates. Another circular has been issued by the Ministry detailing the progress in organization and recruitment of first-aid posts in London. These schemes provide for 131 fixed aid posts, five cleansing stations and thirty-four mobile units. The estimated total of fixed posts required for the County of London is approximately two hundred.

Social Relations of Science

THE British Association announces a meeting of the new Division for the Social and International Relations of Science to be held at the Royal Institution at 4.30 on Thursday, May 25, by permission of the managers of the Institution. This will be the first public meeting of the Division to be held in London. Prof. Ernest Barker, professor of political science in the University of Cambridge, and Sir Daniel Hall, former chief scientific adviser to the Ministry of Agriculture, are to be the principal speakers, with Sir Richard Gregory, chairman of the Division, in the chair. The object of the meeting is to show how science and society are 'out of gear', and the nature of the task which the Division has undertaken in trying to assist in bringing about an adjustment. Prof. Barker is to speak on "The Impacts of Science on Society", showing the repercussions of scientific discovery and invention upon the social structure. Sir Daniel Hall is to deal with the failure to apply science properly by showing how the application of science to agriculture has been impeded. Sir Richard Gregory will deal with the work of the Division. Primarily, the meeting is intended for workers in every branch of science with the view of securing their interest and co-operation in the work of the Division. It will, however, be open to members of the public and to representatives of organizations interested in the work of the Division. Tickets may be had on application to the Secretary of the British Association, Burlington House, Piccadilly, London, W.1. Another important meeting of the Division is to be held at Manchester in June, when the effects of science upon certain industries will be discussed. Work of the Division at present in hand includes questions of nutrition, population, social psychology, the organization of science and the international relations of science. A committee has also been appointed to report on the world sources of raw materials.

Indirect Rule and the Anthropologist

As a principle of administration, indirect rule is essentially a system of local government, in theory functioning through local native tribal institutions. Admirable as this principle may be in intention—its object is at once to conduce to fairness and justice in the maintenance of law and order, while educating the native in a sense of civic and political responsibility, and at the same time affording him an opportunity of gradually adapting his institutions to

the conduct of public affairs on modern lines—yet when the searchlight of anthropological investigation is turned on to indirect rule as a working system, difficulties in giving it full effect and shortcomings in its practice begin to appear. In the earlier days of British administration in Africa, it was assumed, perhaps too readily and without intensive anthropological inquiry, that each local unit must be subordinated to a headman or chief, and ruled by him with or without a council of elders. In either event, it was assumed to be a system susceptible of individual representation. In default of a more penetrating examination, it was not realized that local sovereignty, to use an expressive, if not a fully applicable, term, was bound up with religious ritual, belief and organization, upon which the native was not only reticent, but also incapable of expounding the ramifications except in response to the patient inquiry of an experienced and trained observer. Hence the system of native courts composed of members, who have come to be called 'warrant chiefs', was by no means invariably in accord with native institutions, while the legitimate representative of native authority, according to tradition, was often relegated to the background, either through native reticence or the influence of a more forceful personality.

THE relation of the warrant chiefs to the real seat of native authority has been carefully analysed by Prof. C. Daryll Forde, who, as a Rockefeller Research Fellow of the International Institute of African Languages and Cultures, has made a special study from this point of view of the tribal customs of the large village centre of Umor in the Obubra Division of Southern Nigeria, with a population of more than 10,000 (*Africa*, **12**, 2; 1939). Not only does he show how intricate an affair is native traditional machinery for the preservation of order and for local administration, but he also goes on to show how native custom and principles in local administration have been controverted by the appointments made, in the praiseworthy desire to secure the representation of native knowledge and opinion. At the time of Prof. Forde's investigation in 1935, reform of the composition of the native court was under consideration, and the moral of his report is clearly that any change should be made only after intensive inquiry into the details and essential character of native institutions. He himself has certain constructive suggestions to make; but at the same time he points out that it is now difficult to make that use of native institutions which at one time was open to the Government. The interest of the natives has been diverted from their own institutions to the form which has been imposed upon them by the white man, and among them discussion has tended to centre on the methods of appointing warrant chiefs rather than on any radical reform, which would allow for the incorporation of the traditional system in the administrative machinery, or its development in that direction. Further, the young men have formed a group now actively in opposition to traditional authority in village affairs. It is evident that if native institutions are to be used and developed as a means to native education and civic training, some compromise will have to be effected. Otherwise native institutions and the stabilizing influence of tradition will go by the board.

International Standard for Chorionic Gonadotrophin

AT the third International Conference on the Standardisation of Hormones, held at Geneva on August 11–13, 1938, it was decided that international standards should be established for certain hormones of the anterior lobe of the pituitary gland and analogous substances found in urine and serum, and that international units should be defined in terms of a weight of each standard. The final preparation of these standards, their dispensing in a form suitable and convenient for the use of the laboratory worker, their storage, preservation and subsequent distribution, was to be undertaken by the National Institute for Medical Research, Hampstead, London. The preparation of the international standard for the gonadotrophic substance of human urine of pregnancy (chorionic gonadotrophin) has now been completed. It has been prepared from substantial amounts of material generously provided by six firms in different countries. The individual samples having been approved by the Conference, a mixture was made and the standard has been finally dispensed in the form of 10 mgm. tablets. The international unit has been defined as the specific gonadotrophic activity of 0·1 mgm. of the standard preparation, an amount of activity similar to that required, under the conditions used by many workers, to cause cornification of the vaginal epithelium of the immature rat. Each tablet contains approximately 100 international units. As in the case of the international standards for other hormones, drugs and vitamins, the new international standard is held, on behalf of the Health Organisation of the League of Nations, at the National Institute for Medical Research, Hampstead, London, from which it can be obtained by national control centres established in other countries; workers in Great Britain should apply to the Department of Biological Standards, National Institute for Medical Research, Hampstead, London, N.W.3.

Preservation of the English Countryside

IT may be remembered that at the Cambridge meeting of the British Association, Dr. Vaughan Cornish described his efforts to preserve the natural scenic beauty of the cliff regions near Sidmouth by ensuring that considerable tracts of land in his possession should be restricted entirely to agricultural purposes. *The Times* of April 26 announces that Dr. Cornish has decided to extend these restrictions to cover (during his lifetime) the lands of Thorn Farm, near Salcombe Regis. This is a place of considerable historic interest as well as of natural beauty, which takes its name from an old "Holy Thorn" tree used as a landmark from Saxon times, and replaced with

suitable ceremonial by another whenever it died. This decision has, also, its scientific aspect, on account of the proximity of the Norman Lockyer Observatory to Thorn Farm, where (but for the action of Dr. Cornish) it would have been possible to erect some six hundred houses under the local town planning scheme. It is well known that the work of Greenwich Observatory is badly hampered by smoke and glare from the surrounding district. The erection of six hundred houses in the vicinity of the Norman Lockyer Observatory might have been the first step towards a similar interference with the work of this observatory, and it is a matter of satisfaction that this annoyance has been at least postponed during the lifetime of Dr. Cornish.

Earliest Man

MR. J. REID MOIR, with an admirable sense of propriety, took as the text of his Huxley Memorial Lecture for 1939 before the Imperial College of Science and Technology on May 4 certain questions posed by T. H. Huxley in his famous book "Man's Place in Nature". There Huxley asked: "Where, then, must we look for primeval man? Was the oldest *Homo sapiens* Pliocene or Miocene, or yet more ancient?" Readers of Mr. Reid Moir's lecture in its published form ("The Earliest Men". By J. Reid Moir. London: Macmillan and Co., Ltd. Pp. 32. 1*s.* net) will appreciate the choice as lecturer on this occasion of an investigator of man's origins, who through his association with Edwin Ray Lankester is directly linked with Huxley, and also by his own researches has contributed so much of the material which must be taken into account by everyone who ponders the problems thus formulated by Huxley so long ago. The evidence of man's skeletal remains, as well as of his artefacts, which has been laboriously collected, pieced together and interpreted by numerous investigators since Huxley's day, ably summarized and surveyed by Mr. Reid Moir, may seem formidable enough in its detailed mass, but it is still far from offering a final solution of man's origins. Nevertheless it makes it possible to adumbrate a generalized formula, from which it may be that a concrete answer eventually will emerge. If in the meantime Mr. Reid Moir's technological and æsthetic arguments may seem a little overweighted in the period and degree of man's development they demand, and his credence in Miocene man a thought too readily conceded, none can deny that in his life work he has abundantly shown faith in that of which his powers of observation and reason have convinced him—the belief in the power of truth ultimately to prevail, which Huxley urged upon the youth of his time.

Verulamium Museum

THE new Verulamium Museum at St. Albans, which has been erected by the Corporation at a cost of £8,000, was declared open by the Earl of Harewood on May 8. The purpose of the Museum is to house the finds from the excavation by Dr. R. E. Mortimer Wheeler and the late Mrs. Wheeler between 1930 and 1934 of the Roman city of Verulamium and the pre-Roman Belgic city in Prae Wood. A tablet in the entrance hall commemorates Mrs. Wheeler's part in the excavation. The museum building, of which Mr. F. Newton is the architect, and Mr. Philip Corder will act as curator, contains in addition to offices and laboratories, a museum hall 75 ft. long, in which are displayed a selection of the finest and most typical specimens from the two sites, grouped in an arrangement which will most readily convey their significance to the visitor. The large mass of material still under examination at the Institute of Archæology in London will eventually be stored in the Verulamium Museum, and though not displayed, will be available for students' reference. Three of the finest of the mosaic pavements discovered at Verulamium, including the square pavement displaying the remarkable head of a sea god, and the striking semi-circular scallop-pattern pavement of about A.D. 130–150, are shown on the end-wall, facing the visitor on entering. On the left of the entrance are the wall-cases containing the Belgic pottery, both imported and home-made, from the pre-Roman site of Prae Wood, ranging in date from about A.D. 10–40. The remaining cases are given up to exhibits from Verulamium. The material culture of the inhabitants of the Roman site is exhibited in the long series of burial groups, among which not the least interesting relic is a denarius of Augustus, which was converted into a Mithraic token some two centuries after its issue. A large model of the important south-eastern, or London, gate is also shown.

Preservation of Fauna and Flora

IN an address entitled "The Dawn of a Geological Period" delivered at the London School of Hygiene and Tropical Medicine on May 4 for the University of London, under an arrangement for an exchange of lectures with the Universities of Belgium, Prof. V. van Straelen, director of the Royal Natural History Museum of Brussels, discussed the inroads made on the fauna of the world by the activities of man and especially by the exploitation of Central Africa. He pointed out the fact, which is usually entirely neglected if not always unrealized, that not only are the larger mammals threatened with extinction by the advance of settled areas in tropical Colonies, but also that the felling of rain forests, by exposing the soil to the direct attack of sunlight, renders it impossible to reafforest such lands, and by completely altering all the micro climatic conditions, necessarily causes the destruction of all smaller plants and animals, whether they live above, upon or in the soil. In the light of his own great experience of such conditions, and of others the ultimate effects of which are similar, Prof. van Straelen showed that the changes of fauna and flora which are now occurring are in magnitude analogous to those which characterize the geological periods, and thus justified his title.

Cosmic Rays

PROF. P. M. S. BLACKETT took "Cosmic Rays" as the subject of the thirtieth Kelvin Lecture which he delivered before the Institution of Electrical En-

gineers on Thursday, April 27. He gave a *résumé* of what had been done to discover the nature of these mysterious rays, from their properties. As a rule, engineers consider natural phenomena first of all to find out some possible utility for them. In addition, Prof. Blackett stimulated the imagination of his audience to consider all manner of possible consequences which might arise from the bombardment of the earth from outer space by some twenty particles per minute at astronomical values of electron volts. The effects of cosmic rays can be obtained, shown by experiment and recorded photographically without much difficulty and with quite simple apparatus, but calculation of these effects depends upon equations which, although easily written down, can only be approximately solved with great labour. The labour can be lightened by the use of calculating machines invented by engineers, but it is a lengthy operation. There is little exact knowledge about these rays and it is assumed that they are due to radiation from the extra-solar universe. Interesting accounts were given of the attempts that had been made on these rays by researches in the upper atmosphere, by investigations on the surface of the earth and by experiments below its crust. He said that, in the last case, the necessary apparatus had been installed in one of the underground platforms of the Holborn station of the London Passenger Transport Board, but it was found that the symmetry of the readings was effected by the presence overhead of the tunnel which carries the electric trams below Kingsway.

Photography in Science and Industry

Dr. Olaf Bloch, chief chemist of Messrs. Ilford Limited, delivered the twenty-ninth annual May Lecture before the Institute of Metals on May 10. Dr. Bloch pointed out that the photographic emulsion consists of a finely divided suspension of one or more of the halides of silver in gelatin. There are two broad theories of development, one of which suggests that the process consists in the deposition of silver upon the latent image from the developer which has first become supersaturated, whilst the second postulates increased adsorption at the points constituting the latent image with consequent increase of developer activity in these regions. As to the latent image, we are still without definite proof of its nature. Silver bromide crystals become much more sensitive by the inclusion in them of a small amount of iodide, but the great advance which has been made in emulsion-making technique is largely due to the employment of dye-sensitizers. The second part of the lecture dealt with the applications of photography to industry. By means of the photographic emulsion our powers of observation extend far beyond the limits originally set by the senses, and, further, the grains of the emulsion are rendered developable by the passage of the fast moving particles ejected from disintegrating atoms. Investigations into the nature of cosmic rays are also being actively carried on by the aid of the photographic emulsion. For this work special emulsions have to be prepared, but all are members of a large emulsion family who serve mankind in the making of illustrations for books, in survey work, in photomicrography and photo-telegraphy, for ordinary picture making and record work, and in nearly every field of research.

Sound Transmission from London Television Station

It is well known that the use of ultra-short wavelengths for broadcasting purposes facilitates the attainment of a very high quality in the sound transmission on account of the extensive range of side-band frequencies which may be employed. At a meeting of the Wireless Section of the Institution of Electrical Engineers on May 3, Messrs. I. L. Turnbull and H. A. M. Clark read a paper on "The Marconi-E.M.I. Audio-Frequency Equipment at the London Television Station". This paper outlines the requirements of a high-quality sound equipment and describes the design and constructional features of the Alexandra Palace installation. The final section of the paper gives information on the overall performance of the apparatus and includes data on the frequency and harmonic distortion of the amplifier equipment. The overall frequency response from the microphone to the modulated radio frequency output to the transmitter is practically uniform from 40 cycles per second to more than 10,000 cycles per second; the second harmonic content varies up to a maximum of 0·5 per cent for full (that is, 100 per cent) modulation, while at the same modulation level the third harmonic content is about 0·1 per cent. The authors express the opinion that it is this low odd-harmonic distortion, quite as much as the extended frequency range, that is responsible for the satisfying and pleasing quality of the sound transmitted. The equipment has been in operation for a period of two years with complete satisfaction. It may be remarked in conclusion that, for some time past, it has been the practice of the British Broadcasting Corporation to transmit part of the ordinary National or Regional programme through the Alexandra Palace 'sound' transmitter, so that listeners having a television or other suitable ultra-short wave receiver may take advantage of this high-quality broadcasting station.

Maternal Mortality and Industrial Welfare

In the course of an address delivered to the Industrial Welfare Society on April 28, the Minister of Health, Mr. Walter Elliot, stated that the provisional maternal mortality figures for 1938 have just been received and that they show a further reduction from 3·13 per 1,000 births in 1937 to 2·97 in 1938, the lowest figure ever recorded in Great Britain. Although abnormally large sums have now to be found for defence, there has been no reduction in our social services. The Government's contribution to these services and to the cost of police, roads, etc., has grown by £186,000,000 since 1925, an expenditure that is proving an excellent investment. In addition to the new low record in maternal mortality, during the period 1927–37 the infantile mortality rate has fallen from 70 to 58, and the tuberculosis death

rate from 97 to 69. The toll of sickness upon industry remains, however, very great, for expenditure on benefits under National Health Insurance amounted in 1937 to £28,000,000, but hundreds of firms to-day are safeguarding the health of their staffs.

Earthquakes Registered at European Observatories

FOUR earthquakes of considerable severity have been registered by seismographs in Europe recently. The first, on April 28, was registered at De Bilt (Holland) at 0h. 38m. 15s. G.C.T. and may have been distant a little more than 24°. The second caused the needle on a seismograph in London to swing about 3/5 in. It was recorded at De Bilt on April 30 at 3h. 12m. 0s. G.C.T., and at Uccle at 3h. 12m. 12s. Since the epicentral distance was greater than 100°, observations are awaited from more distant observatories before further computations are made. The third was on May 1, and this is discussed below, being the most important of the four. The fourth was recorded at Kew on May 2 at 13h. 27m. 12s. and may have been an aftershock of the one on the previous day, though a slightly nearer epicentre may be indicated.

Japanese Earthquake of May 1

RECORDS of this earthquake have been reported by the following observatories:

De Bilt	at 6h. 10m. 42s. G.C.T.
Strasbourg	at 6h. 10m. 47s. G.C.T.
Uccle	at 6h. 10m. 47s. G.C.T.
Kew	at 6h. 10m. 52s. G.C.T.
with an aftershock	at 6h. 12m. 32s. G.C.T.

The epicentre distance from all these stations was between 80° and 83° and the evidence points to an epicentre in the neighbourhood of the Oga Peninsula north-west of Akita, a town on the north-west coast of the main island of Japan. Possible epicentral co-ordinates are lat. 39·8° N., long. 139·9° E. The shock occurred at 2.59 p.m. local time and lasted 27 seconds. It caused strong vertical movement locally and there was a considerable amount of surface faulting. In the Oga Peninsula the faulting caused land to slide into the sea, and wrecked many houses. In Akita itself plate glass windows were shattered and shop fronts fell out. The reservoir at Funakawa is reported to have burst its banks and drowned three people. Altogether twenty-six people were killed and thirty-eight injured and many slept out in the open that night. Fortunately, the resulting fires were quickly extinguished by the fire brigades, though railway and telegraph communications were disturbed. Aftershocks were frequent locally for some time and some of these were of considerable severity as the Kew records indicate.

The Colonial Service: Recent Appointments

THE following appointments and promotions in the Colonial Service have recently been made: R. H. A. Merlen, veterinary officer, Gold Coast; E. Burtt, junior entomologist, Sleeping Sickness Research Station, Tanganyika Territory; A. E. Pound, inspector of plants and produce, Gold Coast; G. H. Swynnerton, game ranger, Tanganyika Territory; R. B. Warner, inspector of produce, Nigeria; G. J. L. Burton (senior plant breeder and experimentalist), chief research officer, Agricultural Department, Kenya; G. Griffith (assistant agricultural chemist, Uganda), chemist (soils), Malaya; G. R. Spurrell, (inspector of plants and produce), agricultural superintendent, Gold Coast; Dr. G. J. Williams (assistant geologist, Tanganyika Territory), geologist, Gold Coast; R. G. Newberry (schoolmaster), agricultural education officer, Agricultural Department, Nigeria; W. H. Reeve (late assistant field geologist, Tanganyika Territory), geologist, Nyasaland.

Announcements

SIR CHARLES VERNON BOYS has been awarded the Elliot Cresson Gold Medal of the Franklin Institute, in recognition of his scientific achievements, "which have furnished scientists with new and remarkably precise methods for making measurements in gravitation, in sound, in heat, in radiation, in current and static electricity, so refined as to render possible the weighing of the earth, the determination of the radiant energy coming to us from the stars, the photography of the speeding bullet and the immobilization, even, of the lightning flash itself". The medal will be presented on May 17.

THE Chalmers Gold Medal of the Royal Society of Tropical Medicine and Hygiene has been awarded to Dr. Max Theiler of the International Health Division of the Rockefeller Foundation, New York. The medal has been awarded to Dr. Theiler in recognition of research of outstanding merit in tropical medicine or tropical hygiene particularly in reference to yellow fever, and the possibility of producing the vaccine by the use of attenuated virus.

THE twenty-fifth French Congress of Social Hygiene will be held at the Bordeaux Faculty of Medicine under the presidency of Dr. George Risler on May 19–21. Further information can be obtained from L'Alliance d'Hygiène Sociale, 5 rue Las Cases, Paris.

AN International Meeting on Physics is being arranged during September 4–16 by the Federal Institute of Technology and the Physical Society of Zurich in connexion with the Swiss National Exhibition which was opened by the President of the Swiss Confederation on May 6. The meeting will be divided into five sections, dealing with nuclear physics, physics of the solid body, technical physics, television and high-frequency studies, respectively. Leading scientific workers in these subjects from all parts of the world are taking part. Further particulars can be obtained from the Secretary, International Meeting on Physics, 41 Gloriastrasse, Zurich 7.

THE English Universities Press, Ltd., Little Paul's House, Warwick Square, London, E.C.4, is organizing a competition for schools in the form of question papers on three of its recently published books: "Man against Microbe", "Physical Science in Modern Life" and "Ascaris: the Biologist's Story of Life". The age limit is nineteen years and the competition closes on July 31. Particulars can be obtained from the English Universities Press, Ltd.

Research Items

Petroglyphs of North Central New Mexico

In the eleventh report of the Archæological Survey Series of the University of Denver, Colorado ("Petroglyphs of North Central New Mexico", Anthropological Department, University of Denver. Pp. 58 with plates), Prof. E. B. Renaud gives the results of exploratory investigation of the rock carvings, engravings and paintings to be found in the region centring on Santa Fé, which was initiated in 1932, carried on in succeeding seasons, and finally reviewed in an expedition of 1938. The region to the north and south of Santa Fé, here under survey, is divided into three areas, north, west and south-eastern, mainly on geographical grounds. The petroglyphs found in these divisions do not differ materially in character. The whole region is bisected from north-east to south-west by the great Rio Grande valley. Certain general conclusions are drawn from the detailed descriptions of the sites. All sites, with a single exception, have anthropomorphic representations, whether realistic or schematic, isolated or in groups. Among occupations noted are dancers, flute-players, hunters, and warriors. Several dancers wear headdresses—horns or feathers. There were a few instances of men on horseback. The presence of phallic figures, frequently ithyphallic, is unusually marked. Simple or stylized human figures are present on all sites. Hands are seen at fairly numerous sites, though never many together. Zoomorphic figures are abundant, though not to be identified with certainty, excepting deer. Eight sites display birds, one type being the spread-eagle or 'thunder-bird'. The serpent is omnipresent. Phyllomorphs are rare, and skeuomorphs not numerous. There is a vast class of geometric figures, signs, and symbols. Though no chronology is attempted, the majority of the figures belong to the prehistoric period of the south-west, which in Mexico ends about A.D. 1540, when the horse first became known to the Indians.

Iron Age Settlement in Wiltshire

The excavations of the smaller of two prehistoric sites at Woodbury, near Salisbury, Wiltshire, now being carried on by Dr. Gerhard Bersu on behalf of the Prehistoric Society in pursuance of its recently instituted policy of systematic research in the field, have thrown considerable light on social conditions in the Early Iron Age in Britain. The report on the first season's excavation (*Proc. Prehist. Soc.*, N.S., **4**; 1939) states that in the period from June 12 to September 18 about one fifth of the total area of the settlement of about 15,000 sq. metres, was uncovered down to the chalk. The settlement belongs exclusively to Early Iron Age *A*, and was of long duration. A ditch planned during the existence of the settlement was never completed; but it is evident from analogous sites in the area that some threat, at present of unknown character, forced the inhabitants to defend their open settlements by banks and ditches. This was at a time when hill-forts also were being planned. At one period, a simple palisade surrounded the site; but whether before or later than the construction of the ditch awaits elucidation. The main features of the site are the provision by pits and over-ground structures for the storage of grain after partial roasting, hollows in which it is suggested the harvested grain was prepared for roasting and storage, and two circular structures for habitation—the first of their kind to be found in Early Iron Age *A* in Britain—of which the larger with the longer structural history, and situated in the middle of the enclosure, is clearly the principal building and the residence of the proprietor of the settlement. This settlement was neither a cattle kraal, as had been suggested, nor a village, but a farm in the nature of the subsequent Roman villa.

Revival After Electric Shock

W. T. McNiff has reported (*J. Elec. Workers and Operators*, **36**, 145; 1937) that he is able to revive small animals, which have been apparently killed by electric shock, by the application of a 'counter-shock' of 60 cycle A.C. As Wiggers has shown, the heart in fibrillation can be made to beat normally by the passage of an electric current through it, and this, apparently, is the mode of action of the 'counter-shock'. If the lethal shock is applied through electrodes on the head and tail, revival is not possible, since the central nervous system is destroyed. It follows, therefore, that this method cannot be employed to revive those subjected to legal electrocution. For the method to be effective, the lethal shock must not pass through the head, and the counter-shock must be applied through electrodes on chest and back within four minutes of the patient having received the apparently lethal shock.

Action of Quinine on Skeletal Muscle

A. M. Harvey (*J. Physiol.*, **95**, 45; 1939) has studied the actions of quinine on skeletal muscle, on the motor end-plate, and on the responses of the muscle to various other drugs in frogs, domestic fowls and cats with the following results. Quinine caused an increase in the tension response to a single maximal stimulus in normal, curarized and denervated muscle. This mechanical potentiation was accompanied by an increase in the amplitude and duration of the muscle action potential. The ability of the muscle to respond to a tetanus was diminished owing to an increase in the refractory period of the muscle fibres. The excitability at the motor end-plate was lowered by quinine, and the ability of a tetanus to facilitate conduction at the end-plate was weakened or abolished. Eserine and veratrine were no longer able to evoke repetitive response to a single stimulus in a muscle treated with quinine. The response of the normal mammalian muscle to injected acetylcholine was abolished by quinine. This phenomenon was largely due to the curariform action of the drug, the otherwise similar response to injection of a potassium salt being little affected.

Optical Isomerism and Growth

J. R. Totter and C. P. Berg (*J. Biol. Chem.*, **127**, 375; 1939) have prepared the optical isomers of natural tryptophane, histidine and lysine, and given them to mice in diets deficient only in the corresponding natural form and under conditions analogous to

those previously employed in similar studies on rats. The growth promoted by the unnatural isomers of tryptophane and histidine was found to be slower than that induced by the modifications which occurred naturally in proteins. The response was quantitatively but not qualitatively at variance with that observed in rats. Unnatural lysine in the mouse as in the rat failed to promote growth when added to diet deficient in natural lysine.

Mammals of Tennessee

A USEFUL account of the mammals of this State has been based upon the special survey made by the U.S. National Museum in 1937, supplemented by all the relevant material in the collections of the Museum and of the Biological Survey (Remington Kellogg, *Proc. U.S. Nat. Mus.*, **86**, 245; 1939). The author does not draw any conclusions from his list, but it is apparent that this is a fair sample of the mammals of the eastern States, its notable feature being perhaps the degree to which man has changed the aspect of the original fauna by his interference. The tale is largely one of reduced numbers and extermination. There is scarcely a creature, valued even in small degree for its pelt, which is not reported to be decreasing; even the opossum and raccoon are fewer, mink and skunk are becoming rare, fisher and otter and perhaps beaver are extinct. So with the larger beasts of prey, the grey wolf, black bear and others having been exterminated in many sections. Bison and elk disappeared in the early years of the nineteenth century; even the Virginian deer seems to be on its last legs, though in 1789 where troops were stationed good venison was accepted in lieu of taxes at a value of 9*d*. a pound. On the other hand, there have been additions to the fauna: fifteen wild swine from northern Germany were enclosed in 1912 and multiplied; about 100 broke through the fence in 1920 and now their progeny ranges over an area of 50 square miles. Coyotes have also been introduced recently, "for the purpose of training hounds" it is said; and of course those invariable camp followers of civilization, the house-mouse, black rat, Alexandrine rat and brown rat have long been successfully established.

Distribution of Crop Productivity

IT has been found that an area which produces high yields of one crop, for example, wheat, will as a rule also produce yields above the average of other crops, for example, barley, hay or potatoes. A statistical analysis of the geographical distribution of crop productivity in England (*J. Roy. Statistical Soc.*, **102**, 21; 1939) has been made by M. G. Kendall, head of the Statistical Branch of the Ministry of Agriculture. The economic importance of the results is obvious, but from a wider point of view perhaps the most interesting aspect of the analysis is the application to agricultural economics of methods devised for psychological tests of intelligence. The prevalence of positive correlations between yields of different crops is a phenomenon similar to the prevalence of positive correlations of the results of mental tests. It is natural to ask if there is a coefficient of general productivity analogous to Spearman's *g*, the much-disputed general factor in intelligence. Mr. Kendall offers no fewer than four such coefficients. The first two, the 'productivity' and 'ranking' coefficients, are based on psychological methods. These two coefficients give nearly the same results; the first is preferable theoretically, but the second is much easier to calculate. The third and fourth, the 'money-value' and 'energy' indexes, are spatial index numbers, agreeing fairly well with each other, but not so well with the previous pair. Finally, an attempt is made to estimate the validity of the conclusions reached by psychologists by seeing how far the same arguments hold when applied to crop productivity.

Potato Metabolism and the Blight Fungus

AN interesting paper upon the rates of growth of potato foliage and tubers in relation to attack by the blight fungus, *Phytophthora infestans*, by the late P. A. Murphy, has recently been published (*Sci. Proc. Roy. Dub. Soc.*, **22**, N.S. No. 7, 69–82, February 1939). It has proved relatively easy to eliminate blight, but more difficult to avoid injury to the foliage. The first effect of spraying is usually to check the production of foliage and tubers, and benefits of the fungicidal wash only become apparent later, when the parasite is eradicated. Complete control of the disease without appreciable injury to the plant was effected by weekly applications of dilute solutions of cuprous oxide, with about half the quantity of copper usually given per acre with Burgundy mixture. Maximum production of tubers reached 1½ tons per week during the month of July, after which it fell off, until in September it was not much above ½ a ton per week. The period of maximum tuber production corresponded with that of maximum foliage. Benefits of spraying depend upon the interval between the arrest of production caused by the blight fungus, and the time of normal cessation of growth in September.

Sexual Isolation

ALTHOUGH it has been known for some considerable time that preference in mating was a powerful means of isolating one species or race from another there has been little experimental evidence available. T. Dobzhansky and P. C. Koller (*Biol. Zentralb.*, **58**, 589; 1938) have analysed preferential mating between *Drosophila miranda* and *D. pseudo-obscura* and between *D. azteca* and *D. athabasca*. It was found that in mixed cultures of these species homogametic mating was greatly preferred. Degrees of preference were, however, exhibited when different races of *D. pseudo-obscura* and *D. miranda* were used. Within *D. miranda* two races (Olympic and Whitney) exhibited a small degree of preferential homogametic mating. Although these species have approximately similar distributions in the wild they remain isolated from one another. There are indications that mating preference is genetical in origin and dependent on genes on the autosomes.

Earthquakes of the Pacific Coast of U.S.A. (1769–1928)

THE whole of vol. 29, No. 1 (Jan. 1929), of the *Bulletin of the Seismological Society of America* is taken up with this descriptive catalogue compiled by Sidney D. Townley and the late Maxwell W. Allen. It occupies 297 pages, earthquakes in California taking 232 pages whilst those of Oregon, Washington, Idaho, Nevada, Utah and Arizona take 44 pages in all, the remainder of the volume being concerned with the introductory remarks. The material used in the catalogue has been largely taken from the Holden

(1769–1897) and McAdie (1897–1906) catalogues, and since 1906 from notes by U.S. Weather Bureau observers, newspapers, magazines and the records of individuals and societies interested, all of which are acknowledged by the authors, and all of which have been carefully checked. The catalogue stops at 1928, since after that date the records have been kept and published by the U.S. Coast and Geodetic Survey annually. There are no figures or maps, and indeed it would be difficult to put all the matter accurately on a map unless it were drawn to an abnormally large scale, but it is hoped that in the near future Mr. Townley will arrange that this valuable information be arranged in geographical latitude and longitude order somewhat after the manner of Miss Bellamy's Catalogue, with cross references to the present work, as this would make it much more valuable from both the statistical and the ready reference points of view.

Detection of Nitrous Fumes

THE detection of nitrous fumes, which are encountered in many industrial operations and are dangerous poisons, is described in Leaflet No. 5, "Methods for the Detection of Toxic Gases in Industry, Nitrous Fumes" (H.M. Stationery Office. 3*d*. net) issued by the Department of Scientific and Industrial Research. The test depends on the Griess-Isolvay reaction. The atmosphere under test is drawn by a hand pump through a tube containing the reagent until a rose-pink colour of standard depth is reached, and from the number of strokes of the pump the concentration may be found from a table given in the leaflet.

Distribution of Carbon Isotopes

A SYSTEMATIC study of the relative abundance of the carbon isotopes ^{13}C and ^{12}C in various groups of materials has been made by A. O. Nier and E. A. Gulbransen (*J. Amer. Chem. Soc.*, **61**, 697; 1939) with a mass spectrometer of high sensitivity and high resolving power. The compounds studied were arranged in four groups: (1) igneous carbon (graphite, meteorite and diamond); (2) limestones; (3) plant sources; (4) various (dry ice, air, flesh, coal, etc.). The $^{13}C/^{12}C$ ratio found appears to depend upon the classification of the material. In general, the heavy isotope seems more abundant in limestones and the light isotope in plant forms. The maximum variation in the ratio was about 5 per cent. More data would probably provide a method of determining the origin of carbon compounds in Nature. If the $^{13}C/^{12}C$ ratio in air is assumed to be 90 ± 2, the atomic weight 12·012 is calculated for carbon, with the isotopic weights 12·0041 and 13·0079, and a conversion factor of 1·000275 in going from the physical to the chemical scale.

Structure of Triborine Triamine

TRIBORINE triamine, $B_3N_3H_6$, is iso-electronic with benzene. Fuller implications of this are brought out very elegantly by B. L. Crawford and J. T. Edsall (*J. Chem. Physics*, **7**, 223; 1939) from a study of the long-wave spectroscopy of $B_3N_3H_6$. They have examined the Raman spectrum of liquid $B_3N_3H_6$ and the infra-red spectrum of gaseous $B_3N_3H_6$. The symmetry of the molecule is D_{3h}, and it should therefore have twenty distinct internal vibrations. Of these, seven should appear in the Raman spectrum only (four should be polarized), three should appear in the infra-red spectrum only, seven should be common to both spectra, and three should be inactive in both spectra. These theoretical predictions have been substantially verified by the ascertained spectra, but the number of coincident frequencies is less than the predicted seven. However, by means of a normal co-ordinate treatment of the molecule, it has been possible not only to calculate the force constants of the various bonds but also to calculate all the fundamental frequencies, both active and inactive. This permits the assigning of all observed frequencies. One instance of an isotopic effect, due to molecules containing the isotope of boron of mass 10 has been noted and thermodynamic properties of $B_3N_3H_6$ have been calculated. The interesting comparison of the spectra and force constants of $B_3N_3H_6$ and C_6H_6 which is made leads the authors to favour the assignment of the benzene frequencies made by Lord and Andrews in preference to the assignment of Angus, Bailey, Ingold, and co-workers.

American Meter-testing Methods

IN Mr. Shotter's recent paper to the Institution of Electrical Engineers on April 14, several useful and novel methods of testing electric meters are described which deserve to be better known in Great Britain. He was struck by the fact that Americans have to a large extent eliminated the use of stop-watches in their electrical laboratories, the timing being effected by impulses from a standard clock. This is achieved by the aid of a photo-electric cell. The method consists of keeping a constant load on the rotating substandard electric meters, which are kept under test for a definite time period with the potential circuit of these instruments controlled from the standard clock. A method which appears to be becoming popular is the use of a rotating standard fitted with a stroboscopic attachment, one meter at a time being tested. With the types of meter the Westinghouse Co. is producing the method appears to be very satisfactory. Mr. Shotter saw also a chemical method for cleaning badly corroded and tarnished clockworks and other types of mechanism. The method employed consists in the use of a rotating cleaner containing one or more solutions in which the clockwork is immersed for a short time. Similar apparatus for cleaning watches and clocks has been on the market in the United States for some years. The method appears to have considerable possibilities. Microscopic examination of pivots and jewels was employed in all the servicing laboratories which the author saw.

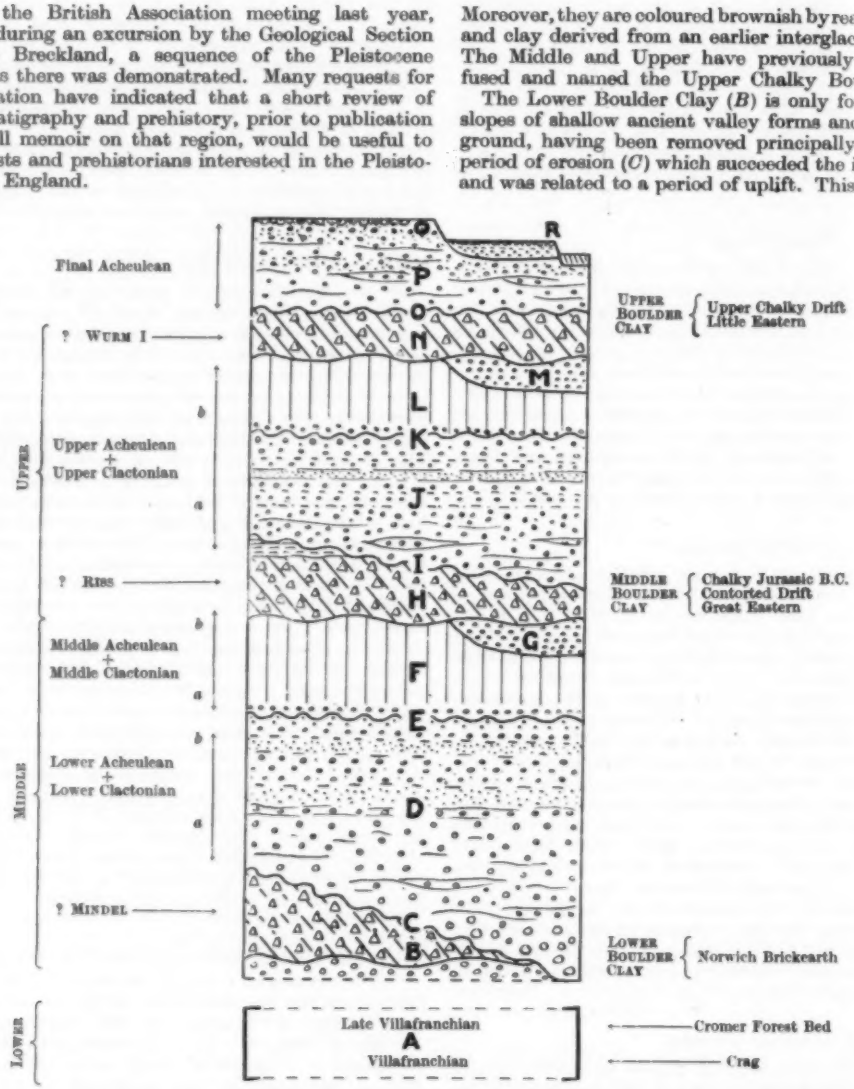
Measuring Focal Lengths of Zones of a Mirror

W. H. NEWMAN'S paper entitled "A Method of Measuring the Focal Lengths of Zones of a Mirror for a Reflecting Telescope" (*J. Brit. Astro. Assoc.*, **49**, 5; March 1939) will prove interesting to all makers of specula. Instead of using a complete Ronchi grating, two fine slits were employed, or, to be more correct, two lines were ruled with a needle on smoked glass, their distance apart being 0·02 in. The glass was smeared with paraffin first as this facilitates the ruling of straight lines, whereas smoking the glass without this paraffin coating may lead to ragged edges. This modification of the Hartmann method of testing was discussed by experts at the meeting of the Association, and some of them were a little dubious of its utility.

Pleistocene Stratigraphy of the Breckland

By T. T. Paterson, University Museum of Archæology and Ethnology, Cambridge

AT the British Association meeting last year, during an excursion by the Geological Section to the Breckland, a sequence of the Pleistocene deposits there was demonstrated. Many requests for information have indicated that a short review of the stratigraphy and prehistory, prior to publication of a full memoir on that region, would be useful to geologists and prehistorians interested in the Pleistocene in England.



There are three boulder clays, called here the Lower, Middle and Upper. The Lower, hitherto called the Great Chalky Boulder Clay, is distinguished by its erratics from Scotland, Yorkshire and Scandinavia, as well as Jurassic and Kimmeridgic material; whereas the Middle and Upper are very much alike, carrying a great quantity of English, especially Triassic, erratics and none from very far parts. Moreover, they are coloured brownish by reason of loam and clay derived from an earlier interglacial deposit. The Middle and Upper have previously been confused and named the Upper Chalky Boulder Clay.

The Lower Boulder Clay (*B*) is only found on the slopes of shallow ancient valley forms and on higher ground, having been removed principally by a long period of erosion (*C*) which succeeded the ice advance and was related to a period of uplift. This must have been quite extensive since valleys several hundred feet deep were then cut out, and it is the period when the major features of the present landscape were decided. A great period of aggradation filled these valleys with gravels (*D*) up to about the level of our present river system. A warm fauna roamed the land surface so established. A period of increased rain deposition led to some slight erosion (*E*) and

subsequent formation of a loam (*F*). Another period of slight aggradation with a temperate fauna (*G*) was followed by advance of an English glacier (*H*), when the land was depressed some 150 feet.

The sequence of the first interglacial was repeated, but during a shorter second interglacial. Uplift was followed by erosion (*I*), valleys being excavated, generally along previously established drainage lines though some deflections occurred. Aggradation (*J*) was continued into a temperate period. A colder oscillation (*K*) was followed by temperate conditions, and deposition of a loam (*L*). A period of slight erosion (*M*) cut into the loam, and the Upper Boulder Clay was then deposited as a skin over the greater part of the Breckland, though not in the hills to the south.

This boulder clay and its associated gravels form an Upper Terrace dissected by an erosion phase (*O*) which cut out the present radial drainage of the Breckland. A Middle terrace was formed of well bedded gravels (*P*). Towards the upper part a cold fauna is succeeded by a bed (*Q*) showing the effects of sludging under severe cold conditions. A period of erosion and aggradation forms a late Low Terrace (*R*).

Because of its general lithological character and physiographic configuration the Lower Boulder Clay (the Great Chalky Boulder Clay of West Norfolk and Suffolk) is equated with the Norwich Brickearth. The Middle Boulder Clay is equated with the Great Chalky Boulder Clay (the Great Eastern Drift) of East Norfolk and Suffolk. The Upper Boulder Clay is equated with the 'Upper Chalky Boulder Clay and Little Eastern Drift'. A more widespread correlation is not possible here, but will appear in the full memoir, which, it is hoped, will be published later this year.

At several horizons palæolithic industries have been discovered. The Acheulean is divisible into Lower *a* and *b*, Middle *a* and *b*, Upper *a* and *b*, and Final. The Clactonian can similarly be subdivided, into Lower *a* and *b*, Middle *a* and *b*, and Upper *a* and *b*. In general, it may be said that:

The Lower Acheul occurs during the early part of the Lower-Middle Interglacial prior to phase (*E*) and is characterized by free flaking, no controlled secondary work, no fine retouch, thickness, cortex remains, irregular outline and dominant pyriform shapes.

The Middle Acheul occurs during the later part of the Lower-Middle Interglacial and is characterized by the presence of much controlled secondary working, some retouch (more in Middle *b*), and linguate and ovate forms dominant. (In southern England the pseudo-Micoquian is dominant in Middle *b*.)

The Upper Acheul appears in the Middle-Upper Interglacial and is characterized by much controlled secondary working, fine retouch including controlled step retouch, thinness, no cortex, very fine and regular outlines (twisted forms common), small foliates, pointed ovates and straight-sided pyriform types dominant.

The Final Acheul appears in the post-Upper Boulder Clay aggradation gravels with the same general characters as the Upper Acheul, somewhat finer if anything, but the 'proto-celt' and the triangular forms appear.

The Lower Clacton occurs in the same period as Lower Acheul, with massive flakes, generally much cortex remaining, no controlled secondary retouch, no specifically prepared forms, and the cores coarsely biconvex and serrate, with no flat-bottomed forms.

The Middle Clacton occurs in the same period as the Middle Acheul and has thinner flakes, cortex wholly removed, controlled secondary working, some retouch, specifically prepared forms, points and such-like, proto-Levallois and Levallois cores, biconvex, serrate and flat-bottomed.

The Upper Clacton occurs in the same period as the Upper Acheul. Apparently the Upper Acheul has absorbed some northern Upper Clacton* elements and the only dominantly Clacton industry is of southern facies†, direct descendant of a Middle Clacton *b* of the Thames. The flakes are equally side- and end-types from biconvex and flat-bottomed cores, and of specific shapes. There are no pseudo- or proto-Levallois flakes or cores. The flakes are strong with median ridges instead of flake scars. There is no secondary working, but finely developed scaling retouch. Outlines are regular.

Faceted, possibly Levallois, flakes are occasionally found but no industry has so far been unearthed.

On broad palæontological and stratigraphical grounds, the Pleistocene is divided into Lower, Middle and Upper. This division corresponds to three cycles of deposition, the first being less marked than the others. Both Middle and Upper begin with extensive land movement. The Lower is so named because of the Villafranchian and late Villafranchian character of the fauna.

* "Tayacian" stem of the Clacton.
† "Mousterian" stem of the Clacton.

British Empire Telegraph Communications

DURING the last ten years very rapid progress has been made in both telegraph and radio communication throughout the British Empire. In a paper by K. L. Wood recently read to the Institution of Electrical Engineers, the engineering aspect of the whole of this world-wide communication is considered. A short history of progress in cable telegraphy is given, but full explanations are given of novel technical methods. Methods of operating radio are also described, and reference is made to the effects of varying cosmic conditions on radio signals.

September 29, 1929, was a notable date in world communication, as on that date all the telegraph communications of the British Empire were, by Act of Parliament, placed in the hands of a single operating company. At the same time an Imperial Communications Advisory Committee was set up, the members of which were nominated by the British and Dominion Governments. A long list is given of the main companies taken over by the operating company. In addition, the ship and aircraft services were taken over as well as various small radio

circuits. In many parts of the world, the cable systems have been reorganized. The terminals of certain radio circuits in South Africa, India, Canada, Egypt and Australia are operated by local companies.

The Post Office also maintains a broadcast telegraph service on long and short wave-lengths. Radiotelephony in the United Kingdom is controlled and operated by the G.P.O., but the overseas terminals in the Dominions are controlled by the local companies or by the operating company. The operating company also handles abroad the shore end of various ship services, some of which are fitted with direction-finding apparatus. At Nairobi, Bermuda and Bahrain, Adcock direction-finding stations for air services are in operation. There are radio-photo-telegraph services with New York, Buenos Aires, Melbourne and Tokio; also land telephony in Cyprus and Peru, and broadcasting in Kenya. The present telegraph system comprises 155,090 nautical miles of submarine cable, 125 wireless circuits, and 161 overseas branches. The tables given show that nearly all the Empire routes from the United Kingdom are served both by cable and by wireless. London stands out clearly as the focal point of the whole system.

During certain periods of the day, much of the traffic between distant parts of the Empire passes through London. For example, South Africa-India traffic may travel via the Cape Town-London beam and the London-Bombay, or via the cable chains over the same route. Many alternative routes to Australia are given. The choice as between wireless and cable is primarily dependent on the senders' instructions; but the particular route is regulated in part by the out-payments that have to be made on the various routes. These depend very largely on the time of traffic flow, and this, again, is largely dependent upon the business times in various parts of the world. During the night on a route which is served both by wireless and by cable, the cable circuit may carry the bulk of the traffic, since the majority of the cable chain stations may have to be kept fully manual to serve other routes; methods have now been devised which largely overcome the effects of 'fading' and 'atmospherics'. Verdan working, while largely eliminating fades and atmospherics, fails when both these factors are present at the same time. Considerable experimental work is still being carried out, but only with limited success.

The author also considers the effect of cosmic conditions on wireless telegraph circuits, and explains how in practice large use is made of the effects of the solar cycle when predicting future conditions. The optimum wave-lengths of transmission for any given route are dependent upon the season and the time of the day and—this is an important factor—the degree of solar activity, which is found to follow approximately an 11½ years' cycle. The last sunspot maximum period was during 1928–29, and the minimum period during 1933–34. The years following the latter period have been accompanied by a marked increase in activity, which on a half-yearly basis exhibited a well-defined peak for January–June 1937. Records for the past hundred years reveal that, whilst the average length of cycle is 11·4 years, the change from minimum to maximum activity occurred over an average period of only 4·5 years; a study of wireless data for the year 1938 indicates that it is not improbable that the year 1937 may prove to have been the maximum peak of the present cycle. Unlike long-wave transmission, it is found that increased solar activity, with its increase in ionization, enhances the utility of the shorter wave-lengths.

At certain times and seasons, the attenuation of wireless signals is so low over both the major and minor arcs of the great circle embracing the two terminals that signals may arrive both by the forward and the backward route, and even encircle the globe some two or three times. Diagrams are given showing the reception at the P.O. station at Bridgwater of two consecutive dots transmitted from Cape Town together with a sequence of three 'echoes' of the main transmission, as the result of the rays encircling the globe three times.

The Gorge Dam, Hong Kong

THE problem of providing adequate water storage to meet the needs of the population of Hong Kong is a peculiarly difficult one by reason of the relatively large population living in a small mountainous area in which the rainfall is confined to the monsoon period of about six months. Although provided with twelve reservoirs with a gross capacity of 3,000 million gallons, there were only seven years since 1921 during which an unrestricted supply of water could be given. Faced with the necessity of obtaining further supplies, the director of public works, Mr. R. M. Henderson, came to the conclusion that the best solution lay in constructing a reservoir which should impound the waters of the Shing Mun—a river situated in an area on the mainland leased from the Chinese Government in 1898 for a period of ninety-nine years and known as the 'leased territory'.

The scheme, as finally developed, provided for the construction of a reservoir having a capacity equal to the combined capacities of the existing reservoirs, thus doubling the provision for the Colony. To give effect to this plan it was necessary to build several dams and, of these, the largest—the Gorge Dam—presents both in its design and in its construction several features of especial interest. These were described in a paper read before the Institution of Civil Engineers by W. J. E. Binnie and H. J. F. Gourley on January 24.

The design selected as most suitable for the purpose and place was based on two principal considerations—economy in construction and the elimination of cracks such as would allow of the penetration of water and might arise from earth tremors or from volumetric changes due to the thermal phenomena exhibited in large masses of setting concrete.

The dam has a height of 275 ft. above the stream-bed and its length at the top is 690 ft. Its main structure, the 'thrust block', is not the actual dam but, in conjunction with the 'rock-fill' and the 'sand wedge', acts as a support for the 'diaphragm' or screen which forms the barrier to the water

This thrust block transmits the water pressure to the rock-fill and presents to the diaphragm a row of buttresses faced with pre-cast concrete blocks. Against these blocks leans the diaphragm, which forms the main water face and is an articulated structure composed of vertical panels 25 ft. in width. Each panel was made in 'lifts' of 20 ft. at one operation and is reinforced with a 'grille' of steel rods 1¼ in. in diameter.

Every precaution was taken to ensure water tightness, and when the reservoir was filled to top water-level there was no leakage whatever. The spaces between the buttresses, the centres of which are 12½ ft. apart, and the function of which is to support the diaphragm, constitute inspection pits whereby the diaphragm can be examined. Access is obtained to these pits by branch galleries connected with the main galleries, which are reached by steps from both ends of the dam. These pits would also, in emergency, act as interceptors of any water leaking from the reservoir and so prevent it entering and disturbing the sand wedge. It will be apparent that the design adopted has produced a structure possessing considerable flexibility so that disturbances might take place without giving rise to more than minor and controllable cracking. The details by which this result is obtained are described and illustrated in the paper.

River Physics in India

ONE of the major problems of India is that of the rivers, and it was with the object of inviting the attention of the central and provincial Governments to the urgency of making investigations on scientific lines that a symposium was organized by the National Institute of Sciences of India a little more than a year ago. The several papers presented have now been published (*Proc. Nat. Inst. Sci. India*, 4, No. 4) and show the profound interest that is being taken in the subject by a number of well-qualified workers. The presidential address by Prof. M. N. Saha pointed out the importance of the rivers to the agricultural life and as a means of the industrialization of India, and dealt with their influence on the level of cities on their banks, instancing the destruction of many ancient cities and the increasing difficulty now being experienced in the drainage of Calcutta by reason of this action (see also NATURE, 141, 797; 1938).

"The Post-Tertiary Hydrography of Northern India and the Changes in the Courses of the Rivers during the last Geological Epoch" were dealt with in a paper by D. M. Wadia, in which he traced the tectonic movements which have caused widespread and radical alterations in the whole system of drainage lines. The number, volume and direction of the units of this system bear evidence of changes which in some instances have amounted to the complete reversal of the flow of such a principal river as the Ganges. In a paper on the "Changes in the Drainage of India as evidenced by the Distribution of Freshwater Fishes", Dr. S. L. Hora adduced evidence from various sources to show that there was a reversal of the drainage in the post-trappean period. From the nature of the valleys of the rivers and from certain other features of the physiography of the peninsula, it is concluded that the present-day lower portions of the rivers are of great antiquity, whereas the upper reaches are comparatively recent.

Coming more closely into touch with the nature of the problem of the present day, one of the difficulties facing the engineer is the construction of works in an alluvial boulder river bed, and the problems in respect of river training thereby presented have yet to be solved. Associated with these is the need for constructing irrigation canals transporting alluvium from the river on such lines as should ensure a condition of working stability and tend neither to silt nor to scour. This aspect is dealt with in a paper, "Flow of Water in Alluvial Channels", by G. Lacey, in which he directs attention to those elementary principles which help to clarify issues and restrict generalization in river physics. He submits the view that despite the complexity of the problem presented by the great Indian rivers, the basic equations are of a simple nature and that it is on the foundation of the 'normal' or 'regime' channel flowing with constant discharge and silt charge that our ultimate knowledge of river physics must be based.

In his address on "The Use of Models for Elucidating Flow Problems based on Experience gained in carrying out Model Experiments at the Hydrodynamic Research Station, Poona", C. C. Inglis described several types of models and explained why some present little difficulty and yield results suitable for immediate application. Other types, especially those relating to alluvial rivers, present great practical difficulties, and in these cases, the data available are usually too meagre. In so many instances the problems presented are too urgent, requiring immediate steps to arrest the damage that is taking place. The magnitude of this class of problem is shown by the statement that during two years the cost of repairs to the Hardinge Bridge over the Ganges amounted to nearly a million pounds. Such questions require an intimate knowledge of the engineering side of the matter combined with a flair for diagnosis and a capacity to visualize a remedy.

It is the silt carried down by the floods which is at the root of much of the trouble. It has created the land, and made it habitable; it has also fertilized it and made it prosperous. But, as is shown in S. C. Majumdar's paper, "River Problems in Bengal", it has also, by damaging the river channels, caused their diversion through lower areas, leaving the other to become derelict. By raising the beds and consequently the flood level, the silt has created another set of problems, and it is the silt which has destroyed many of the tidal rivers in Central Bengal and is threatening also the cross channels so valuable to navigation. The concluding paper by Dr. N. K. Bose, entitled "River Physics Laboratories of Europe and America", deals briefly with what is being done on these lines elsewhere, but ultimately it must prove that the solution of the problems of India must be found by long and concentrated study of local conditions.

Science News a Century Ago

Exploration in North America and Abyssinia

AMONG the papers read at the meeting of the Royal Geographical Society on May 13 was an account of the recent arctic discoveries of Messrs. Dease and Simpson. This was communicated by the Governor and Committee of the Hudson Bay Company, and when thanking the Company the president announced that two gold medals had been awarded to the explorers. A map was displayed showing the discoveries of Franklin, Ross, Dease and Simpson in 1837–38 and from this it was shown that 150 miles had yet to be explored to connect the recent discoveries with those of James Ross in 1832 and Captain George Buck in 1834.

At the same meeting, Antoine Thompson d'Abbadie (1810–97) gave an account of his recent travels in Abyssinia with his brother Michel Arnaud d'Abbadie (1815–93). They started from Jeddah and visited Massawah, Adowah and also Gondar, from which place Michel endeavoured to penetrate to Enárea.

The Royal Society

AT a meeting of the Royal Society on May 16, 1839, a paper entitled "On the Visibility of Certain Rays beyond the Ordinary Red Rays of the Solar Spectrum" was read by J. S. Cooper, who had sent it to Faraday. The author stated that he had observed an extension of the red portion of the solar spectrum, obtained in the ordinary way, beyond the space it occupies when seen by the naked eye, by viewing it through a piece of deep blue cobalt glass. He had found that the part of the spectrum thus rendered perceptible to the right was crossed by two or more very broad lines or bands; and he observed that the space occupied by the most powerful calorific rays coincided with the situation of the red rays thus rendered visible by transmission through a blue medium.

Ductile Thread from Rock Salt

IN a communication printed in the *Athenæum* of May 18, 1839, a foreign correspondent said: "M. Gaudin, one of the employés of the Observatory of Paris, has just submitted to the Academy of Sciences a process for converting Rock Salt into ductile thread. You must not shake your head at this, M. Gaudin is no quack. The Academy, at any rate, received his memoir with marked favour. Everybody knows that glass when in a state of fusion, may be drawn out into very slender threads; and M. Gaudin having succeeded in melting down rock salt, discovered that it was susceptible of the same modifications as vitreous substances—that it could be wound round a bobbin, or converted into a solid tissue at will. But of what use, you may say, is this discovery. According to M. Arago there are various ways of turning it to good account. The Torsion balance (la balance de torsion) which in the hands of Coulomb has proved so useful is rendered *uncertain* by the variable elasticity of the wires which support the electric or magnetic needle. To remedy this defect, there can be no surer way than to substitute rock salt threads for the metallic wires now employed". There are other applications equally interesting.

Marc Antoine Augustin Gaudin was born April 5, 1804, and for a long time was a calculator for the Bureau des Longitudes. He devoted much time to researches in optics and in photography.

Societies and Academies

Paris*

Academy of Sciences (*C.R.*, 208, 953–1060, March 27, 1939).

R. FAIVRE and A. MICHEL: Chemical composition and crystalline structure of the product of slow oxidation of magnesium in a moist medium. The black compound formed seems to be brucite (a magnesium hydroxide) with additional magnesium atoms inserted in the lattice.

C. BARON: Use of light metals in the composition of explosives with an ammonium nitrate base. Addition of powdered aluminium increases the power of the explosive by 10–12 per cent.

P. JACQUET and P. ROCQUET: Application of electrolytic polishing to the micrographic examination of iron and steels.

G. COSTEANU and P. RENAUD: Action of water on sodium, copper and mercury.

H. GUÉRIN: Arsenates of calcium; study of the system $As_2O_5 - OCa - OH_2$ at 17°.

J.-M. DUNOYER: Reduction by hydrogen of allotropic varieties of manganese dioxide.

MLLE. B. TCHOUBAR and O. SACKUR: Alkaline deshalogenation of chloro-1 cyclohexylmethyl-ketone and of chloro-1 cyclohexylphenyl-ketone; transposition in α-substituted cyclohexylformic acids.

D. BODROUX: Preparation of true acetylenic hydrocarbons.

L. DENIVELLE: Butane diol-2, 3 and its esters.

M. TUOT: Carbonation of organo-magnesium compounds and the secondary reactions which accompany it in the aliphatic series.

R. PAUL: Reactivity of the two dienic systems of furylethylene.

A. MICHEL-LÉVY and J. WYART: Synthesis of anorthite by pneumatolysis with the help of an explosive (hexogene).

R. ABRARD and E. A. DE LA RÜE: Marine quaternary formations in the neighbourhood of Obock (French Somaliland).

G. DELÉPINE: Extension and characteristics of the marine fauna of the oil basins of Djerada (Morocco) and Kenadza (Southern Oran).

H. BREUIL, L. AUFRÈRE and MME. A. BOWLER-KELLY: The *Elephas meridionalis* alluvial deposits of the Carpentier quarry near Abbeville.

E. PELLERIN: A water-sampling bottle. A metal tube of capacity about 2½ litres is used; the limit of depth is about 250 metres.

MLLE. J. SALMON: Formation and structure of the sieve tubes in the hypocotyledonary axis of *Cucurbita pepo*.

A. BRUNEL and R. ÉCHEVIN: Assimilation of allantoin by the higher plants.

E. POZZI-ESCOT: A case of xenia in the vine.

G. NICOLAS and MLLE B. AGGÉRY: Effects of the simultaneous presence of three parasitic fungi in *Senecio vulgaris* L.

MME. S. LALLEMAND: Action of colchicine on the chick embryo at different stages of development. The strophosomic reaction is only produced in embryos of 40–68 hours.

A. VANDEL: Mode of distribution of the sexes of the terrestrial isopod, *Armadillidium vulgare* (Latr.). Proportions of the sexes are extraordinarily variable.

M. LECAMP: Regeneration of buccal pieces in phasmids.

(*Continued from p. 774.*)

N. FETHKE : Action of the salts of normal saturated fatty acids on phagocytosis *in vitro*.

J. LAVOLLAY and MME. F. LABOREY : The lactoflavine produced by *Aspergillus niger* V. Tgh. is characteristic of culture media partially deprived of magnesium.

J. CUILLÉ and P.-L. CHELLE : Experimental transmission of 'trembling' in the goat. Virus from a sheep suffering from this disease produced 'trembling' in goats after a period of 25–26 months.

Cracow

Polish Academy of Sciences (March 6, 1939).

J. WEYSSENHOFF : Variations of the integrals of hypersurfaces under an invariant form.

A. BIELECKI, M. MATHISSON and J. WEYSSENHOFF : A theorem concerning a transformation of quadruple integrals into curvelinear integrals in Riemann space.

K. DJIEWOŃSKI, W. DYMEK and J. MOSZEW : New syntheses and transformations of compounds of the type of the 2-aryl-4 arylamino-quinolines (13).

K. KONIOR : Interglacial beds of Wilamowice.

MME. H. WOJTUSIAK, R. J. WOJTUSIAK and A. BURSA : Quantitative researches on the fixed fauna and flora on the piles in Polish ports.

F. ROGOZIŃSKI : (1) Transformation of chlorophyll in neutralized chyme. (2) Chlorophyll in human digestion. Scarcely three per cent of ingested chlorophyll appears in the fæces, whereas in ruminants 12–22 per cent is eliminated.

Moscow

Academy of Sciences (*C.R.*, **21**, No. 3 ; 1938).

W. NIEMYTSKI : (1) Systems of curves filling a metric space. (2) Families of curves of the Bendixon type.

I. TAMM : Isotope shift of spectral lines and the interaction of neutrons with electrons.

M. BORISSOV, V. P. BRAILOVSKI and A. I. LEIPUNSKI : Primary ionization with fast electrons in nitrogen.

G. A. BARSKI and J. B. ZELDOVICH : Heat transfer of gas to walls of a vessel by free convection.

P. A. CHERENKOV : Absolute output of radiation caused by electrons moving within a medium with super-light velocity.

V. VEKSLER, K. ALEKSEEVA and N. REYNOV : Heavy electrons in cosmic rays.

W. I. VERNADSKY : Biochemical role of aluminium and silicon in soils.

F. LOEWINSON-LESSING : Some queries on classification and nomenclature of igneous rocks (2).

N. B. VASSOEVICH : New data on the stratigraphy of Upper Jurassic and Neocomian of north-eastern Azerbaidjan.

N. T. KAKHIDZE : Chromomere structure of wheat chromosomes.

A. S. AFANASSIEVA : Effect of comallarine upon seeds of summer wheat.

W. J. BUT : A quantitative dredge for investigating benthic population of plant communities in water.

C.R., **21**, No. 4 ; 1938.

W. K. TURKIN : Normal divisors in the groups of odd order.

P. E. DUBUQUE : Fundamental theorem of Frobenius.

W. K. TURKIN and P. E. DUBUQUE : A criterion for non-simple groups.

N. D. MORGULIS and B. I. DIATLOVITSKAJA : Ionization of sodium atoms on the surface of thoriated tungsten.

G. FRANK-KAMENECKIJ : Secondary radiation produced by the penetrating component of cosmic rays.

I. I. KORNILOV : Conversion velocity of supersaturated solid solutions of magnesium-aluminium.

O. E. ZVIAGINCEV and I. A. PAULSEN : Action of minerals on gold solutions.

B. N. SCHWANWITCH : Stereo-effect of cryptic colour patterns in Lepidoptera.

N. A. MAXIMOV : Increase of permeability of protoplasm in wilting plants.

N. A. MAXIMOV, M. M. GOCHOLASHVILI and V. I. TSKHOIDZE : Root-formation induced by heteroauxin in cuttings of subtropical plants difficult with regard to rooting.

A. P. SČERBAKOV : Physiological role of elements indispensable for plants in minute amounts.

SERGIUS LVOFF and E. L. LIMBERG : Effect of inorganic phosphates on the formation of citric, gluconic and oxalic acids in *Aspergillus niger*.

V. S. MURATOVA : Ecological and geographical classification and evolution of beans (*Vicia Faba* L.).

A. A. WOITKEWITSCH : The influence of thyroidectomy on the development of ducklings.

S. YUDITSKAJA : Growth and differentiation of embryonic muscles in the extremities of a chicken.

L. F. BEREZKINA : Interrelation between the fibres existing in the tissue during explantation and those formed anew *in vitro*.

K. MARTINSON : Fossil sponge fauna of Tertiary deposits around Lake Baikal.

S. N. SEMICHATOVA : Some results of investigation of the internal structure of Carboniferous brachiopods.

Tokyo

Imperial Academy (*Proc.*, **15**, No. 2, February 1939).

YASIO MUTÔ : Generalized circles in the conformally connected manifold.

KINJIRO KUNUGUI : On a theorem of Seidel and Reurling.

TATSUO KAWATA : Boundedness of the spectrum of a distribution function.

MISHIO ISHIMOTO : Characteristic of a seismic fault and its course.

JURO HORIBETI and MASATUGU IKUSIMA : Mechanism of the hydrogen electrode process on platinum (2).

SIN'ITI KAWAI, TAKAO NAKAMURA and NOBORU SUGIYAMA : Researches upon ergonol (continued). A new general synthetical method for 2-phenylcumarone and its derivatives and the synthesis of egonal.

SHIGEHIKO SUGASAWA and NORIO SUGIMOTO : Oxidation of some β-phenylethylpyridinium – and – quinolinium salts.

SHIGEHIKO SUGASAWA and KITTIRO KAKEMI : Studies on the synthesis of dibenzopyridocoline derivatives. (2) Synthesis of 4′, 5′-dimethoxy-4″, 5″-methylenediomy-3, 4, 5, 6-tetrahydro-(1′, 2′ : 1, 2 ; 1″ ; 2″ : 7, 8-dibenzopyridocholine) and the corresponding tetramethoxy derivative.

JUN SUZUKI : Age of the Sambagawa system.

NOBUHIKO OBARA : Studies on the nature of the sea-water and the bottom materials of Heda Bay, Izu Peninsula, Sizuoka Prefecture.

Forthcoming Events

[Meetings marked with an asterisk are open to the public.

Monday, May 15

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Dr. E. B. Worthington: "Echo-Sounding of British Lakes".

Tuesday, May 16

ST. MARY'S HOSPITAL, LONDON, W.2, at 5.—Dr. A. S. Parkes, F.R.S.: "The Hormones of the Anterior Pituitary Body".

EUGENICS SOCIETY (at Royal Society, Burlington House, W.1), at 5.15.—Prof. A. M. Carr-Saunders: "Some Problems of Population".*

CHADWICK PUBLIC LECTURE (at the Royal Institute of British Architects, 66, Portland Place, W.1), at 5.30.—G. H. Henderson: "Comparative Study of the Housing of the Working Classes, with Special Reference to Scotland".*

Wednesday, May 17

ROYAL MICROSCOPICAL SOCIETY (at B.M.A. House), at 5.30.—F. C. Bawden: "Some Properties of Plant Viruses".

Thursday, May 18

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society), at 5.—Prof. J. E. Lennard-Jones, F.R.S.: "Order and Disorder in Nature".

CHEMICAL SOCIETY (at the Institution of Mechanical Engineers), at 6.—Prof. C. N. Hinshelwood, F.R.S.: "Some Considerations on the Nature of Catalysis" (Liversidge Lecture).*

Friday, May 19

GEOPHYSICAL DISCUSSION (at the Royal Astronomical Society), at 4.30.—"The Night Sky and Aurora" to be opened by Prof. S. Chapman, F.R.S.

ROYAL INSTITUTION, at 9.—Prof. J. D. Cockcroft, F.R.S.: "New Phenomena in Liquid Helium".

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

ASSISTANT (grade I) for the Research and Technical Publications Section of the Air Ministry—The Under-Secretary of State, Air Ministry, Berkeley Square, London, W.1 (*Ref. B* 196. May 19).

CHIEF DESIGNER, ASSISTANT CHIEF DESIGNER and ASSISTANT (grade II—chemical problems) at the Royal Aircraft Establishment, South Farnborough—The Chief Superintendent (May 19).

SENIOR LECTURER IN PHYSICS in the Bradford Technical College—The Principal (May 20).

ASSISTANT LECTURER AND DEMONSTRATOR IN GEOLOGY in University College, Cork—The Registrar (May 27).

CHEMIST in the Admiralty Chemical Pool—The Secretary of the Admiralty (C.E. Branch) (Ref. C.E. 5028/39. May 27).

ASSISTANT LECTURER IN ORGANIC CHEMISTRY in King's College, London—The Secretary (May 30).

LECTURER IN PHYSIOLOGY in King's College, London—The Secretary (May 30).

DEMONSTRATOR IN CHEMISTRY in King's College, London—The Secretary (June 1).

ASSISTANT LECTURER (OR LECTURER) IN PHYSICS in University College, Southampton—The Registrar (June 1).

ADVISER IN AGRICULTURAL CHEMISTRY and HEAD OF THE DEPARTMENT OF AGRICULTURAL CHEMISTRY in University College, Aberystwyth—The Principal (June 5).

PROFESSOR OF CHEMISTRY in Natal University College, Pietermaritzburg—The Universities Bureau of the British Empire, 88A, Gower Street, London, W.C.1 (June 12).

SCIENTIFIC SUPERINTENDENT OF RESEARCH IN FOOT-AND-MOUTH DISEASE at the Experimental Research Station, Pirbright, Woking, Surrey—The Secretary, Foot-and-Mouth Disease Research Committee, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1 (June 23).

ASSISTANT STATISTICIAN at Rothamsted Experimental Station, Harpenden—The Secretary.

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

Imperial Bureau of Plant Breeding and Genetics. Bibliography of Baking Quality Tests, Supplement. Pp. 32. 1s. 6d. The Action and Use of Colchicine in the Production of Polyploid Plants. By J. L. Fyfe. Pp. ii+10. 1s. (Cambridge: School of Agriculture.) [134

Iron and Steel Institute. Special Report No. 24: Second Report of the Alloy Steels Research Committee. Pp. xx+390+22 plates. Special Report No. 25: Eighth Report on the Heterogeneity of Steel Ingots. Pp. xix+322+26 plates. (London: Iron and Steel Institute.) [134

University of Sheffield. Report on Research Work carried out in the Departments of Mining and Fuel Technology during the Session 1937-38. Pp. 18. (Sheffield: The University.) [144

Other Countries

U.S. Department of Agriculture. Leaflet No. 175: Eradication of the Cultivated Black Currant in the White Pine Regions. By J. B. Martin. Pp. 8. (Washington, D.C.: Government Printing Office.) 5 cents. [134

University of Washington Publications in Anthropology. Vol. 7, No. 3: Tsimshian Clan and Society. By Viola E. Garfield. Pp. 167-340+4 plates. (Seattle, Wash.: University of Washington.) [134

Commonwealth of Australia: Department of Health. Recommendations for Protection against X-Rays, Radioactive Radiations and Ultra-violet Light. Pp. 17. (Canberra: Government Printer.) [134

Ministry of Public Works, Egypt: Physical Department. The Nile Basin. By Dr. H. E. Hurst and Dr. P. Phillips. Vol. 5: The Hydrology of the Lake Plateau and Bahr El Jebel. (Physical Department Paper No. 35.) Pp. x+251+103 plates. (Cairo: Ministry of Finance.) P.T. 100; 20s. [134

Publications of the Dominion Astrophysical Observatory. Vol. 7, No. 3: The Definitive Orbit of the Spectrographic Binary Beta Arietis. By R. M. Petrie. Pp. 105-114. Vol. 7, No. 4: The Spectrographic Orbit of H.D. 195986. By Andrew McKellar. Pp. 115-120. Vol. 7, No. 5: One Hundred and Thirty-two New Variable Stars in Five Globular Clusters. By Helen B. Sawyer. Pp. 121-132+3 plates. Vol. 7, No. 6: The Calculation of Rotation Factors for Eclipsing Binaries. By R. M. Petrie. Pp. 133-140. Vol. 7, No. 7: The Spectrographic Orbit of Boss 3511. By W. E. Harper. Pp. 141-148. (Victoria, B.C.: Dominion Astrophysical Observatory.) [134

Proceedings of the U.S. National Museum. Vol. 86, No. 3053: The Cactus-Feeding Phycitinæ, a Contribution toward a Revision of the American Pyralidoid Moths of the Family Phycitidæ. By Carl Heinrich. Pp. 331-414+plates 23-51. (Washington, D.C.: Government Printing Office.) [134

Smithsonian Miscellaneous Collections. Vol. 98, No. 5: Utilizing Heat from the Sun. By C. G. Abbot. (Publication 3530.) Pp. 12+2 plates. (Washington, D.C.: Smithsonian Institution.) [134

The Rockefeller Foundation. A Review for 1938. By Raymond B. Fosdick. Pp. 72. (New York: Rockefeller Foundation.) [134

U.S. Department of the Interior: Office of Education. Bulletin, 1937, No. 10: Economic Status of College Alumni. By Walter J. Greenleaf. Pp. x+207. (Washington, D.C.: Government Printing Office.) 25 cents. [134

University of Illinois: Engineering Experiment Station. Bulletin No. 307: An Investigation of Rigid Frame Bridges. Part 1: Tests of Reinforced Concrete Knee Frames and Bakelite Models. By Prof. Frank E. Richart, Prof. Thomas J. Dolan and Tilford A. Olson. Pp. 46. 50 cents. Bulletin No. 308: An Investigation of Rigid Frame Bridges. Part 2: Laboratory Tests of Reinforced Concrete Rigid Frame Bridges. By Prof. Wilbur M. Wilson, Ralph W. Kluge and John V. Coombe. Pp. 76. 85 cents. Bulletin No. 309: The Effects of Errors or Variations in the Arbitrary Constants of Simultaneous Equations. By George H. Dell. Pp. 52. 60 cents. Bulletin 310: Fatigue Tests of Butt Welds in Structural Steel Plates. By Prof. Wilbur M. Wilson and Prof. Arthur B. Wilder. Pp. 56. 65 cents. Circular No. 36: A Survey of Sulphur Dioxide Pollution in Chicago and Vicinity. By Alamjit D. Singh. Pp. 32. 40 cents. (Urbana, Ill.: University of Illinois.) [134

League of Nations: Child Welfare Information Centre. Summary of the Legislative and Administrative Series of Documents of the Child Welfare Information Centre published in 1938. (Official No.: C.72.M.33.1939.IV.) Pp. 58. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 1s. [134

Dominion of Canada. Report of the Department of Mines and Resources, including Report of the Soldier Settlement of Canada for the Fiscal Year ended March 31, 1938. Pp. 330. (Ottawa: King's Printer.) 50 cents. [134

Magnetic Observations of Sunspots, 1917-1924. By George E. Hale and Seth B. Nicholson. (Publication No. 498.) (Papers of the Mount Wilson Observatory, Vol. 5, Parts 1 and 2.) Part 1. Pp. iii+91+8 plates. Part 2. Pp. ii+692. (Washington, D.C.: Carnegie Institution.) 10 dollars. [134

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106A: Ergebnisse Aerologischer Beobachtungen. 26, 1937. Pp. 42. 1.50 f. No. 108: Seismische Registrierungen in De Bilt. 24, 1936. Pp. viii+53. 0.80 f. ('s-Gravenhage: Rijksuitgeverij.) [134

Smithsonian Institution: U.S. National Museum. Bulletin 172: Birds from Siam and the Malay Peninsula in the United States National Museum collected by Drs. Hugh M. Smith and William L. Abbott. By J. H. Riley. Pp. iv+582. (Washington, D.C.: Government Printing Office.) [144